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JOURNAL
OF
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VOL. 23 AUGUST, 1930 NO. 4

Proceedings of the Fifth Annual Meeting of the Cotton States Branch, American Association of Economic Entomologists

The fifth annual meeting of the Cotton States Branch was held at Jackson, Miss., on February 6 and 7, 1930. The attendance was greater than at any previous meeting of the Branch, there being 92 names on the attendance record. The program required the time of two long sessions, and special attention was given to the results of investigations of insects attacking crops in the Southern region. Due to the number of papers submitted for the program, it was necessary to limit some of them to a reading of only the abstracts. Of special interest was the address by Wilmon Newell on the Mediterranean Fruit Fly. The president of the parent association, Franklin Sherman, was in attendance, and since he was not present at Des Moines when he was elected, he was duly inducted into office at the Cotton States Branch meeting. The entomologists were guests at banquets on the nights of February 6 and 7, and also at a reception given by the Governor of Mississippi. The meeting was concluded on February 8 with a tour to the Delta Laboratory at Tallulah, Louisiana, where all phases of the cotton insect work was explained and a program provided by the members of that Laboratory. The attendance at Tallulah was 40. The visiting entomologists were guests of the Tallulah Chamber of Commerce for dinner.

PART I. BUSINESS PROCEEDINGS

The meeting was called to order by Chairman B. R. Coad at 2:00 P. M. on February 6 in the Edwards Hotel at Jackson, Miss. The following members were present:

Amsler, F. P., Gulfport, Miss.
Anderson, W. E., Baton Rouge, La.
Arnold, G. F., A. & M. College, Miss.
Bentley, G. M., Knoxville, Tenn.
Bibby, F. F., College Station, Tex.
Bieberdorf, G. A., Stillwater, Okla.
Bishopp, F. C., Washington, D. C.
Bond, G. T., Laurel, Miss.
Bondy, F. F., Tallulah, La.
Bradley, G. H., Mound, La.
Brunson, M., Picayune, Miss.

Carpenter, H. H., Houston, Miss.
Cassidy, T. P., Tucson, Ariz.
Chance, O. M., Jackson, Miss.
Coad, B. R., Tallulah, La.
Cockerham, K. L., Biloxi, Miss.
Colmer, R. P., Moss Point, Miss.

Deen, O. T., Biloxi, Miss.
Deen, R. B., Tupelo, Miss.
Dietrich, Henry, Lucedale, Miss.
Douglass, N. L., Grenada, Miss.
Douglas, W. A., Crawley, La.

English, L. L., Spring Hill, Ala.
Ewing, K. P., Tallulah, La.

Fenton, F. A., El Paso, Texas.
Folsom, J. W., Tallulah, La.

Gaines, R. C., Tallulah, La.
Goodgame, L. J., Aberdeen, Miss.
Gray, W. L., Natchez, Miss.
Grimes, D. W., Durant, Miss.
Grimes, M. L., Meridian, Miss.

Hamner, A. L., A. & M. College, Miss.
Harned, R. W., A. & M. College, Miss.
Hester, J. G., A. & M. College, Miss.
High, M. M., Gulfport, Miss.
Hinds, W. E., Baton Rouge, La.
Hines, Chesley, Yazoo City, Miss.
Hull, F. M., College Station, Tex.

King, M. V., Mound, La.
Kislanko, J. P., Wiggins, Miss.

Langston, J. M., A. & M. College, Miss.

Larrimer, W. H., Washington, D. C.
Lee, J. E., Poplarville, Miss.
Leiby, R. W., Raleigh, N. C.
Livingston, B. P., Montgomery, Ala.
Lyle, Clay, A. & M. College, Miss.

Maloney, G. A., Tallulah, La.
Marcovitch, S., Knoxville, Tenn.
Milton, Jack, Corinth, Miss.
Moreland, R. W., Tallulah, La.
Moznette, G. F., Albany, Ga.
Myers, L. E., A. & M. College, Miss.
McEvilly, J. E., McComb, Miss.
McGehee, T. F., Holly Springs, Miss.
McNeel, T. E., Mound, La.

Newell, Wilmon, Gainesville, Fla.
Noble, L. W., Tallulah, La.

Osterberger, B. A., Baton Rouge, La.

Parish, H. E., A. & M. College, Miss.
Peets, N. D., Brookhaven, Miss.
Price, B. C., Mobile, Ala.

Reed, T. B., Picayune, Miss.

Sasscer, E. R., Washington, D. C.
Sherman, Franklin, Clemson College, S. C.
Smith, F. A., Senatobia, Miss.
Snapp, Oliver I., Fort Valley, Ga.
Spencer, Herbert, Baton Rouge, La.

Worthington, G. I., Cleveland, Miss.

Yeomans, M. S., Atlanta, Ga.

Report of the Treasurer

Balance on hand, Feb. 6, 1929		$ 6.72
Refund from parent association for expenses for year ending Feb. 5, 1929		23.73
Contribution		1.00
1929 annual dues from 41 members		41.00
1930 annual dues from 1 member		1.00
Paid out		
Stamped envelopes	$22.03	
Printing announcements and programs	6.25	
	$28.28	$73.45
Balance on hand Feb. 6, 1930	45.17	
	$73.45	

Report of the Secretary

The number of members in the Cotton States Branch on December 31, 1929, was 216. There was a net increase of 11 members during the year, after dropping those who had moved out of the Branch territory or who were dropped by the parent association for non-payment of dues. This increase in membership was due largely to the continued effort on the part of the Branch to secure new members. The net increase in 1928 was 23. During the last three years the membership has grown from 158 to 216, after dropping those who had moved out of the Branch territory during that period or who had not kept up their dues in the parent association. So the number of new members added to the Branch roll during the last three years was even more than the number represented by the increase in the Branch membership.

The number of members by states at the close of 1929 was as follows: Texas 45; Louisiana 38; Mississippi 34; Florida 22; North Carolina 17; Tennessee 17; Georgia 14; Alabama 11; South Carolina 9; Arkansas 7; Oklahoma 2. The following states showed net increases during the year: Texas 10; Louisiana 4; Alabama 2; South Carolina 2; Arkansas 1; Georgia 1. These states showed net decreases: Mississippi 4; Florida 2; Tennessee 2; Oklahoma 1. There was no change in the number of members in North Carolina.

There are now 209 entomological workers in the 11 Cotton States who are not members of this Branch. Many of these are eligible, and members are urged to assist in continuing our efforts to strengthen our Branch by increasing the membership.

In accordance with the recommendations of the committee on policy which were adopted at our last annual meeting, your Secretary advised each member of the Executive Committee of the Association of Southern Agricultural Workers that more time is needed for our sectional meeting and requested permission to schedule sectional meetings for the mornings if necessary. That committee considered this matter at their meeting in Atlanta, Ga., on last April 5. They decided that it would be better not to have sectional meetings in the mornings, but that full time and attention be given to the general broad phase of agricultural development in the South, during the morning sessions, and that the afternoons, and if desired the evenings, be given to sectional meetings. However, they decided to schedule general sessions for the Jackson meetings during the mornings only, so that both afternoons and evenings may be devoted to sectional programs if desired.

In December, 1929, a notice in regard to the Jackson meeting was sent to each member of the Branch, and a program for the meeting was mailed to each member during the latter part of January, 1930. After the last annual meeting a copy of the financial statement of the Branch was sent to our members.

At the last final business session of this Branch, it was ordered that the annual dues shall be $1.00, and the Treasurer was instructed to mail annually to each member a notice of the dues and a statement of the financial condition of the Branch. This notice was mailed to each member on last May 2, and to date only 41 of our 216 members have paid their 1929 dues. Members in arrears are requested to pay up promptly. Dues for 1930 are now payable.

Chairman Coad announced the committee appointments as follows: Nominations, W. E. Hinds, G. M. Bentley, and Franklin Sherman. Resolutions, J. W. Folsom, R. W. Leiby, and R. W. Harned. The

committee on policy consisting of R. W. Harned, Oliver Snapp, and J. W. Folsom and the committee on publications consisting of Herbert Spencer and Oliver Snapp were continued by motion and vote. W. E. Hinds called attention to a cotton insect exhibit for the Chicago Century of Progress Exposition in 1933. The Branch approved cooperation with this project and named W. E. Hinds chairman of a committee to get up the exhibit. By motion and vote the following were appointed to assist with this work: B. R. Coad, R. W. Harned, and G. A. Maloney.

Final Business

The final business was transacted late in the afternoon of February 7. Chairman Coad called for the report of committees.

Report of the Committee on Policy: This committee recommended (1) That a time limit of ten minutes shall be set for each paper in the future. (2) To be eligible for acceptance, the title of a paper must be sent to the secretary before January 1, together with an estimate of the time required for the presentation of the paper. (3) The Secretary shall, as usual, send invitations to all members to participate in the meetings, but shall mention the action taken by the Branch if the second recommendation is approved. These recommendations were adopted by motion and vote.

The Publications Committee called attention to the fact that an abstract must accompany all papers presented for publication, and instructed those who read papers at the meeting to send them with abstracts to the Secretary at the earliest date if they had not already been turned in.

The following report of the Resolutions Committee was accepted and adopted by motion and vote:

(1) We were especially pleased to have in attendance our colleagues from Washington: E. R. Sasscer, W. H. Larrimer, and F. C. Bishopp.

(2) The banquets given by the Commercial Members of the Association of Southern Agricultural Workers and by the Chilean Nitrate Educational Bureau added greatly to the enjoyment of the meetings.

(3) Thanks are due to the local committee and to the management of the Edwards Hotel for effective and courteous assistance of many kinds; also to many individuals and organizations who have helped to make our meetings a success.

The following report of the Cotton Insect Exhibit Committee was adopted by motion and vote:

A meeting of the Committee was held at Jackson on the morning of February 7 and a general discussion of the exhibit of cotton insects resulted in the following suggestions:

1. That the Mexican cotton boll weevil be made the principal species and central theme of this exhibit.

2. That as a background on the walls of the exhibit room, if three walls are available therefor, there should be in the center an outline map of the Cotton Belt extending westward to include Texas. On this map may be shown by 5-year intervals the advance lines of the boll weevil and in various sections of the Cotton Belt (somewhat in the style of some of the old Spanish maps) small scenes typical of various parts of the Cotton Belt, these scenes fading out at the edges. On the left hand wall possibly a typical scene of the old time cotton plantation before the coming of the boll weevil, with negro cabins and families and cotton field typical of that period. In contrast to this on the right hand wall the typical new scene of the up-to-date cotton farmer of the present time illustrating various phases of the application of the extension program in cotton production. This would include something of livestock, legumes, etc., and a comparison of typical cotton fields as recommended at the present time with their yields.

3. In connection with this exhibit we would like to have an enlarged model of the Mexican cotton boll weevil, female, which might show general facts of structure more plainly than the observer would see under a microscope. If this were prepared with the wings spread, it might be suspended as if in flight. In addition to this there should be enlarged models of the developmental stages: egg, larva and pupa also, leading up to the adult.

4. Probably a series of wax models might show well the cotton bud in its development through the square age and typical damage thereto by the weevil; the bloom shown as a section and the relationship of the floral parts to the ovary explained, and also the fully grown, but unopened bolls with typical weevil injury thereto.

5. In some way, and probably by placards and diagrams, the development of the Farm Demonstration work and the present Extension Service should be shown as an outcome of the boll weevil fight. Similarly there is a direct relationship to the tick eradication movement and its present high degree of exemption from tick infestation.

6. The economics of the boll weevil fight may be shown in summary through the effect upon prices for cotton and cotton seed; the volume and value of the cotton crop for the country; the farmers' income from cotton; the relationship to the living standard of the farmer and the

health of his family, and the development of public schools, improved roads, etc.

7. The development of the cultural control methods for fighting the weevil which are fundamentally important in increasing yields and decreasing weevil damage.

8. The development of direct methods of weevil control, including particularly the use of poisons such as calcium arsenate and the machinery for applying these poisons to cotton. In this exhibit would probably be shown typical machines for hand dusting, the saddle gun, probably the latest type of light engine driven duster, and finally a model of the insecticide-dusting airplane. This model is already available.

9. Probably as a wall-case exhibit there should be a series of specimens of the principal cotton insect pests including the cotton leaf worm, the pink bollworm, the cotton plant louse, the cotton flea hopper, cotton boll worm, etc.

10. Among contributing factors the work of the plant breeder has developed many new varieties which are far superior to old varieties and have helped to meet boll weevil conditions. Comparative exhibits of photographs of plants or actual plant specimens, and of bolls and of lint should be shown with the increased value of the line for the longer staple varieties. The changes that have been made in spacing of cotton and its effect upon high yields per acre should be indicated.

Typical plants illustrating unpoisoned cotton which has been heavily infested by the boll weevil in comparison with heavily fruited plants of the same variety which have been protected by poison would be a striking feature of the exhibit.

11. For use in the rest room or moving picture room nearby, moving picture reels showing the various steps in the fight against the boll weevil are available and others bringing this subject up to date will be prepared.

12. Enlarged photographs, charts, diagrams, etc., will be used to show certain features in many phases of this exhibit.

13. If possible to include it, an economic summary showing the governmental expenditure in the weevil-control fight, possibly something of the state expenditures in this fight from the beginning up to date and the value of the results in the larger yields and more valuable crops of cotton; in relation to the U. S. manufacturers of cotton goods and the U. S. balance of trade, etc.

It is quite apparent that our difficulty will be to condemn, boil down, and simplify this exhibit so as to include the most striking features of

these many phases within the space allowed. Further suggestions, criticisms, or changes on the part of the members of the Committee or others interested are earnestly solicited.

The Nominations Committee presented the following names for officers during the ensuing year: Chairman, J. M. Robinson, Auburn, Ala.; Vice-Chairman, S. W. Bilsing, College Station, Texas; Secretary-Treasurer, Oliver Snapp, Fort Valley, Georgia. By motion and vote the report was accepted and the officers duly elected by casting a single ballot.

Upon motion of the Secretary, the Branch voted to hold the 1931 meeting in Atlanta, Georgia, at the time set for the annual meeting of the Association of Southern Agricultural Workers.

PART II. ADDRESSES AND PAPERS

THE ENTOMOLOGIST IN RELATION TO COTTON INSECT PROBLEMS OF TODAY

By B. R. COAD, *In Charge Cotton Insect Investigations, U. S. Bureau of Entomology*

ABSTRACT

Publicity given cotton insects in recent years has created an impression of great increase in damage, but statistics indicate that while there has been some little tendency of the sort, this impression has been largely created because the farmers have become more observant of their insect problems. Some form of reasonably profitable control measure is available for all major pests but recent developments producing overlapping infestations of several pests in the same field have brought about such a complicated situation that timely localized advice is frequently needed. The U. S. Bureau of Entomology has been testing an experimental cooperation with the research and extension workers in the States of South Carolina and Oklahoma where weekly field surveys of insect activity are made and used as a basis for prompt advice to the farmers. The experience gained warrants the belief that some similar system could be used to advantage in many other sections of the cotton belt.

Just what are insects doing to our cotton crop? It seems that each year we read and hear more of insect attacks here, there and everywhere throughout the Cotton Belt. As a result, we find an impression that there has been a tremendous increase in insect activities on cotton, and that the task of the farmer in raising cotton has become more difficult. This feeling has grown to the point where it is well to pause and consider carefully, balance the books as it were, and see what changes have taken place and how these affect the entomologists of the cotton states in their duties to the farmer.

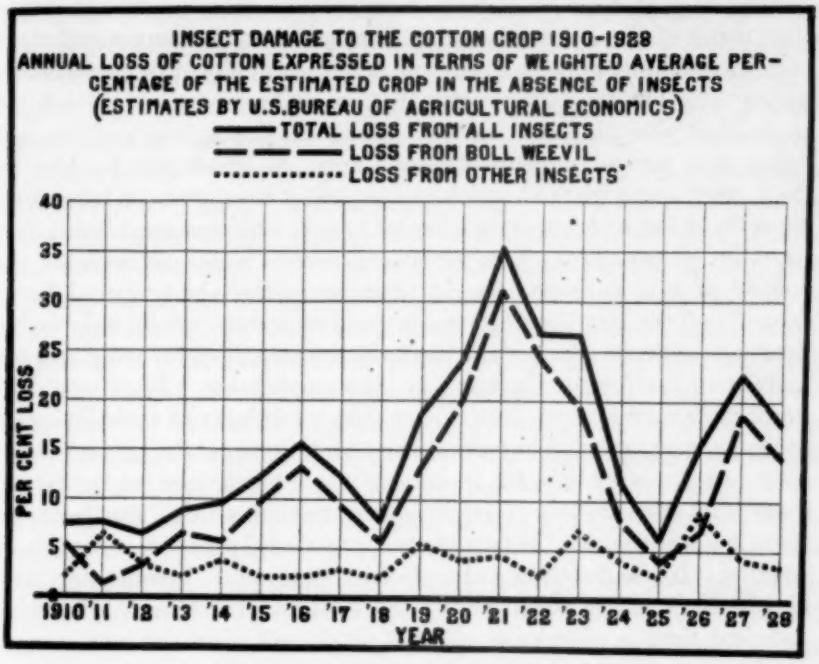
For the past score of years I have had the privilege of being in an office which serves as a sort of clearing house for insect questions and

complaints by cotton farmers. The first half of this period covered the final stages of the weevil's march across the Cotton Belt, and the boll weevil far overshadowed all other pests as a subject for discussion. In more recent years, however, there has been a remarkable change, and we hear more and more of other pests, until one would get the impression that the boll weevil has lost its prestige and that the future of the cotton crop was tottering before the threat of these other pests. We have attempted to analyze this situation and find just how far this feeling is justified.

At the outset, it immediately becomes obvious that this idea is due largely to reports originating on the farm. It is also equally obvious that the cotton farmer of today is a very different individual in his attitude toward entomological problems from the farmer of a score of years ago. For the past few years we have heard a great deal about the American people becoming "air-minded," but I wonder if many of us realize the fact that the cotton farmer is becoming "insect-minded." There is no question that the cotton farmer of today has more appreciation of his entomological problems and is more alert to detect insect attack than ever before. Consequently, damage that a few years ago was overlooked or vaguely attributed to weather or other causes, is now detected and the proper pests given the blame in an increasing proportion of cases. This change in attitude is easily understandable and is due to a combination of many causes. The educational activities of the Extension organizations of the various states and the Federal Government have had the greatest effect. In addition, we have a greater percentage of farmers with technical agricultural training. The spectacular battles being waged against some of our principal pests, or those threatening invasion, have had a great publicity value for entomology and have served to advertise the practical importance of entomological problems. In view of these increased tendencies toward observation and alertness, it is to be expected that there would be more talk of insect damage even without any actual change in the field situation. Consequently, this publicity becomes unreliable as an index to damage and it is necessary to seek further to find the true picture.

The best source of positive information we have, consists of figures furnished by the Bureau of Agricultural Economics of the United States Department of Agriculture. Each year this organization makes a careful estimate of the loss of cotton caused by all insects, and this loss is subdivided into that caused by the boll weevil and that caused by all other pests. The chart has been prepared to show these estimates for the period from 1910 to 1928. In interpreting this, it should be

remembered that the boll weevil did not complete its march across the Cotton Belt until 1922. At the beginning of the period under consideration, weevil damage and other insect damage total somewhat similar figures, but weevil damage soon left that of the other insects far to the rear. Then followed a period of recession in weevil activity, to be followed still later by another period of acceleration. Judging from the


INSECT DAMAGE TO THE COTTON CROP 1910-1928
ANNUAL LOSS OF COTTON EXPRESSED IN TERMS OF WEIGHTED AVERAGE PERCENTAGE OF THE ESTIMATED CROP IN THE ABSENCE OF INSECTS
(ESTIMATES BY U.S.BUREAU OF AGRICULTURAL ECONOMICS)
TOTAL LOSS FROM ALL INSECTS
LOSS FROM BOLL WEEVIL
LOSS FROM OTHER INSECTS
PER CENT LOSS
40
35
30
25
20
15
10
5
1910 '11 '12 '13 '14 '15 '16 '17 '18 '19 '20 '21 '22 '23 '24 '25 '26 '27 '28
YEAR

relative positions of the curves, weevil publicity compared with references to other pests should have been about the same during the past few years as during the period from about 1916 to 1919, but, as has been pointed out, quite the opposite is true. This is easily accounted for by the fact that during the earlier period the weevil was still continuing to spread into new territory and we were confronted with the panic phase of publicity, which has not been encountered in the later years. Another important factor influencing this chart and its interpretation is the increased use of control measures for cotton pests which has taken place during the period covered. Not only have various indirect measures become standard practices, but direct control measures are now applied over enormous acreages both for the weevil and for other pests, and there is no doubt that without these measures, both direct and indirect, the loss figures of later years would be considerably higher than those shown.

Weighing the situation from every angle, it seems evident that there has been an increase in general insect activity on cotton but that this increase is probably not so great as would be thought judging merely from publicity. The problem then remains to see how this affects the duties of the Entomologists of the South.

Fortunately, the Entomologist now knows how to control, at least to a reasonable degree, practically all of our major cotton insects. It is true that many of these control methods are still in a developmental stage and that as time goes on they will be either modified or replaced by better ones, but the fact remains that we do know methods which are reasonably profitable and feasible. However, in the final analysis, the value of a control measure depends upon its suitability for use by the farmer and a method which yields perfect results under laboratory supervision but which is not subject to popular practical application may prove to be worthless. One great weakness of some methods for the control of cotton insects lies in their comparatively technical background and the fact that they can be used most successfully only with a thorough understanding of the fundamental principles involved and the exercise of intelligent discretion in their application. They would be much more useful if iron-clad, rule-of-thumb instructions could be issued to be followed under all circumstances but, unfortunately, this is not the case. At the same time the increasing insect-mindedness of the farmer makes him more capable of properly using these methods. Furthermore, there is a tendency on the part of any agricultural practice, regardless of whether it is insect control, cultivation or what not, to become standardized to the average conditions of the locality. In other words, given sufficient time, a practice is adopted which will yield the best average results over a period of years, although it may not be the one best suited to any one particular case which might be selected. Just now, we are passing through such a formative period and it is at such a time that the entomological and educational forces can be of most service to the farmers.

A few years ago it began to appear as if averaging or standardization of most of these control measures would be comparatively simple, but since then we have been greatly impressed with the complications which have arisen at numerous places throughout the Cotton Belt owing to overlapping infestations or, in other words, the simultaneous activity of several different pests. During recent years we have had insect control studies in several localities where as many as five different major pests affected the same field during the course of the season. Under such circumstances, control recommendations for any one individual pest

necessarily became influenced, and frequently completely changed, by the activities of the other pests. This makes a very complex situation to deal with and one which, in the light of our present knowledge, requires a rather high degree of technical observation, and we have not yet progressed to the point where control recommendations have been so simplified that the average farmer can deal with such a complicated problem to best advantage. This is a situation in which he needs immediate skilled advice based upon his localized conditions and as such problems have been impressed upon us, we have been attempting to devise some means by which such assistance can be rendered without requiring too cumbersome an organization or a prohibitive expense.

Fortunately, for reaching the farmers the research workers already have at their disposal a tremendous organization in the Extension forces of the South, and the problem resolves itself into one of securing the necessary timely and localized information, weighing and interpreting this, and then transmitting suitable recommendations through these forces. In development of such an idea, we have tried several experiments in cooperation during the past few years, particularly with the Experiment Station and Extension workers of the States of South Carolina and Oklahoma, where entirely different cotton insect problems are presented. In each of these states, the research and educational workers have combined forces and worked out a joint program, under which a few research workers lay out the state by insect zones and make regular surveys of insect activity in each of these zones throughout the season of battle. The work so far has been entirely on an experimental basis, the effort having been to ascertain the type of information needed, the man-power required, the best methods of dissemination of advice, etc., but, generally speaking, this information has been transmitted to a control headquarters about once a week, analyzed there, and timely advice immediately issued whenever and wherever it was required. The procedures followed have not been perfect and there is no doubt that further experience will result in making such a service more and more useful, but the results so far have been encouraging, and we feel that such a service could be developed throughout those sections of the Cotton Belt suffering greatest insect damage, at comparatively little cost and with great benefit to the farmers. We find that one research worker can keep up with a remarkably large territory, and with proper experience it is probable that from one to three such men could supply the information needed in almost any southern state. We have also been much interested in following the independent activities of the State Plant Board of Mississippi, which has taken advantage of the fact

that it has trained men scattered throughout the state, to utilize these men incidentally to their other duties, in assembling timely information on account of cotton insects. Undoubtedly there are many states in which such incidental service could be utilized at little or no additional expense.

Such surveys have a two-fold value. They not only serve to provide technical information to serve as a basis for timely advice to farmers but they also serve to call the attention of the research organizations which have been behind them to definite, specific research problems requiring investigation and to offer many clues to the worker in dealing with these problems. Consequently, it seems to us that the greatest single step which could be taken today toward further reducing the insect loss to cotton would be the widespread development of such organizations. Perhaps they would need to be permanent to deal with new insect problems and new aspects of old problems which may arise with changed production methods; if so their cost would be a splendid investment. On the other hand, it might be found that after a period of years there would be a sufficient averaging of problems, or what might be called an equilibrium of methods might be reached, and this special service would be no longer needed. Just now, however, there is certainly a crying need and the cotton farmer is in a receptive mood.

CALCIUM ARSENATE TESTS, 1929, A PROGRESS REPORT ON SMALL-SCALE TESTS COMPARING BOLL WEEVIL CONTROL WITH LUCAS' GREEN CROSS CALCIUM ARSENATE VS. A "STANDARD BRAND" OF CALCIUM ARSENATE

By W. E. HINDS, *Entomologist Louisiana Experiment Station*

ABSTRACT

These two forms of calcium arsenate were tested in the field in various ways. The Lucas materials showed indications of some advantages in dusting qualities and in adhesion to cotton in spite of rains. It appeared to be slightly more efficient in reducing the percentage of squares attacked by the boll weevil in the plats dusted with this material and in the yield of cotton secured from an average of the four treated plats. In cage toxicity tests where weevils were exposed for twenty-four hour periods on dusted plants, the Lucas material gave an average mortality of 58% for the six successive periods of 24-hours exposure while "standard brand" calcium arsenate gave an average of 38%. These results were from three series of tests.

Early in the season of 1929 our attention was called to the advisability of conducting some tests with calcium arsenate materials which were being offered for sale in Louisiana for boll weevil control. The manufacture of calcium arsenate has been better standardized during recent

years than that of any other of our insecticide materials. However it is recognized that there is always a possibility of improving such materials in some respects so as to render them more efficient or more profitable in their use. Therefore arrangements were made to conduct a limited test of the Lucas Kil-Tone Special Calcium Arsenate in comparison with one of the widely used and generally satisfactory brands which for our purposes we will refer to as "standard brand" calcium arsenate.

One of the first demonstrations of a difference in physical qualities between such different brands of calcium arsenate consisted in throwing, or blowing a small amount of each against a plate glass show window. The "standard brand" material fell along the glass surface with very little adherence to the glass, while the Lucas material fell somewhat more slowly and showed a rather high degree of attraction to the glass. The difference in these two dust streaks was so apparent that it could be photographed easily with a hand camera.

This observation led to the first series of tests which consisted of duplicated applications of each dust to large panes of glass set vertically in the open field and then dusted. One glass in each pair was moistened slightly with the mist from an atomizer before the dust was applied. The other was dusted dry. These tests were kept under observation for the effect of winds, dews and rain for a period of about five days. On the third day there was a rainfall of .92 inch. This rain was of the heavy dashing type and washed off most of the dust. After the rain the largest residue of dust appeared to be on plate 1 which had been dusted dry with the "standard brand" of calcium. Very little dust adhered to plate 2 which represented the dew condition at the time of dusting. Still less residue appeared upon plates 3 and 4 which were treated respectively dry, and with dew, with the Lucas brand.

These tests were repeated and the results after another heavy rain were very similar to the series described above.

Applications to cotton were next in order and preliminary tests applied to adjacent rows showed that it was necessary to standardize the amount of dust applied to a given area in order to secure comparable tests. The physical qualities of the Lucas material were very evidently superior in fineness and even flow of material through the dust gun. This resulted in a considerably heavier application of the Lucas material being made where the usual throttle opening and crank revolution speed were maintained. Therefore, it was decided to use a "plunger type" of hand duster in these tests and the weight of dust discharged with each type of dust was correlated with the number of full strokes of the plunger required to throw out the same weight of material. The applications of

dusts in the test were then made so as to give a practically uniform amount of dust discharged upon each test plat.

In arranging the field tests to determine the effect of each type of dust upon boll weevil control under usual conditions, two rows of cotton were used. The arrangement of plats is shown below.

	Plat A	Plat B	Plat C	Plat D	Plat E
Row 1.....	"Standard"	Lucas	Check	Lucas	"Standard"
Row 2.....	Lucas	"Standard"	Check	"Standard"	Lucas

Each plat was 30 ft. in length. Plats 1-A and 2-A were dusted in the first adhesion test on July 1 and again on the 6th. In each of these tests the "standard" showed more conspicuously on the foliage before rains occurred but disappeared more completely during rains. In each test the adhesion of Lucas material was considerably more conspicuous after the rains fell. There was no burning from either dust.

Square infestation records were used as a measure of efficiency of each dust, and were taken by examining 100 squares in each plat in the usual manner. The first examination for square infestation was made before the first dust application and examinations were continued for two weeks after the last dusting. The examinations were started on July 11 and dust applications were made on July 11, 15 and 17, also rainfall occurred as follows:

SQUARE INFESTATION, DUST APPLICATION, AND RAINFALL THROUGH TESTS

July Dates	Dusted	Rainfall Inch	Square Infestation Records, % Check	"Standard"	Lucas
11.....	11	—	12.5	15.7	11.25
13.....	—	.24	—	—	—
15.....	15	.03	4.0	3.0	1.5
16.....	—	.46	—	—	—
17.....	17	—	—	—	—
18.....	—	.18	—	—	—
19.....	—	—	17.5	2.75	4.5
21.....	—	.02	—	—	—
24.....	—	.40	20.5	6.5	5.0
25.....	—	.37	—	—	—
27.....	—	.20	—	—	—
28.....	—	.20	—	—	—
29.....	—	.18	—	—	—
30.....	—	.14	—	—	—
31.....	—	—	65.5	44.0	36.0

An examination of the figures in the table indicates that the Lucas material reduced the square infestation somewhat more than did the "standard" material. Furthermore it appeared to maintain its advantage over the "standard" material quite consistently during the 2 weeks of very showery weather which followed the last dust application date.

While these tests were entirely too limited to justify any final conclusions therefrom, they did give an indication of advantage in favor of the Lucas material. Considering various factors which might be involved in securing this result, it appeared that the finer dusting quality of the Lucas material aided in securing a more even and efficient distribution of the dust through the plants and also there appeared to be superior adhesion and longer continued protection of the plant in spite of rains.

In order to check more carefully on the actual toxicity to weevils, a series of Cage Tests was started on August 1. The usual type of screen cages, about 4 ft. in each dimension and with a door opening so that the observer could enter the cage, was used. The plants to be treated were carefully selected, examined thoroughly to remove all weevils, the ground covered with white cloth so that weevils falling from the plants might be found, the plant dusted and the cage placed over it. Ten weevils were then placed in each cage on the plant. At the end of 24 hours an examination was made and all weevils removed, noting the number dead and the number alive. The living weevils were kept on fresh unpoisoned squares for 2 days longer and those dying meantime were presumed to have secured a killing dose of poison during their exposure in the cage and were, therefore, included in the final record of the number killed from each day's exposure on the plant. A fresh lot of 10 weevils was placed on the plant to test the proportion killed through the second day and so on for each succeeding day until the number killed became too small to be considered of value in the further protection of the plant.

It is not worthwhile to give all of the details of these tests which were repeated in three series. An average of all of the records is secured by averaging the proportion of weevils killed for each day of exposure to the dust during the 6 days for which each series was run. This average shows that the Lucas material killed approximately 58% of the weevils which were exposed to it for 24 hours only, while the "standard brand" of dust killed approximately 38% under the same conditions.

The final figures for yield at the end of the season were secured by making an accurate count of the number of bolls which had matured and had been picked out on each series of plats. The average number of bolls required to give 1 pound of seed cotton in this field was 75. The average number of bolls matured and picked, per plat length of 30 row feet, was as follows: Check 216; "standard brand" dust 263; Lucas special dust 283. The average yield per acre on this basis would be at the rate of 960 pounds of seed cotton for the check, 1170 pounds

for the "standard" dust and 1260 pounds for the Lucas dust. The "standard" dust showed a gain from 3 dustings amounting to 210 pounds of seed cotton per acre and the Lucas material showed a gain of 300 pounds per acre above the check and 90 pounds gain over the "standard" dust. Estimating the value of seed cotton at 6c per pound, it would appear that the use of Lucas dust, in this case, with 3 dust applications, was worth somewhat more than $5.00 per acre in net profit above the profit from the use of a "standard" brand of calcium arsenate.

This Progress Report is made at this time because we feel that these limited tests show "indications of superiority" in the Lucas brand of special calcium arsenate which justify much more extended investigation. The tests reported above were made by Mr. H. F. Stout under the writer's general direction.

NOTES ON *PARATHERESIA CLARIPALPIS*[1] VAN DER WULP, A PARASITE OF *DIATRAEA SACCHARALIS* FABR.

By H. A. JAYNES, *Associate Entomologist, Bureau of Entomology, U. S. Department of Agriculture*

ABSTRACT

Observations are given on the life history of the dexiid parasite, *Paratheresia claripalpis* Van der Wulp, in Argentina and Peru. Notes are included on the varying percentages of parasitism on the different stages of the sugar-cane moth borer, *Diatraea saccharalis* Fabr. It has been found that this parasite can withstand cold storage when in the puparium, and that shipments can be made over long distances.

Collections were made during the year from August, 1928, to September, 1929, in Argentina and Peru of a dexiid fly parasite, *Paratheresia claripalpis* Van der Wulp, which attacks the sugar-cane moth borer, *Diatraea saccharalis* Fabr., and shipments of this parasite have been made from these countries to Louisiana. Inasmuch as some of the other countries growing sugar cane are considering the possibilities of importing this parasite, it may be well at this time to note some of the observations to date.

This fly was described by Dr. Townsend (3) and later he published a short account of its life history in Peru (4). It was also described from the Argentine by Dr. Bréthes as *Sarcophaga diatraea* (2). The synonomy has been noted by Mr. Box. (1)

[1]The fly has recently been called *Paratheresia signifera* Tns., but according to Dr. J. M. Aldrich the proper name is *Paratheresia claripalpis* Van der Wulp.

During the winter months in Argentina, as well as in the summer months, this parasite can be found in the larval, pupal and adult stages. However, the real hibernating stage is in the larval form within the host borer. Those parasites that do succeed in developing through to the pupa stage emerge on warm days, and, unless there follows a period of warm weather long enough to allow the flies to mate and larvaposit, they die without attacking a host. Along the coast of Peru the winter months are not severe enough to cause hibernation.

Even though the borer damage of the cane was very high at this time of the year, in some cases reaching 100% of the stalks and 50% of the joints infested, the actual number of borers present in the cane was relatively small. The proportion of good parasite puparia found was not exceeding 5% of the number of borers present. To obtain any large number of parasites at this period required a considerable amount of labor in cutting out borers.

Later, when the young cane was coming up, "dead hearts"[2] were cut out and examined for parasitized borers and fly puparia. Parasitism was found to run from 2% to 22.72% in Argentina. This included puparia found at the time and those developed later from the borers. In Cartavio, Peru, the percentage was found to be higher—in one field only 7%, but in three other fields the average was 32%, and this included only the actual puparia present and borers then showing signs of parasitism. The remaining borers which were saved for rearing were destroyed by a laborer by mistake. Even when the percentage of parasitism was as high as 30% or more it was necessary to cut from 8 to 10 "dead hearts" to obtain one parasite, as there were a number of "dead hearts" containing no borer or parasite, the borer having been killed by other causes or having left the plant.

By the end of December, 1928, corn was being cut green as fodder for cows in Tucumán, and upon examination it was found that certain fields were heavily infested with the moth borer. Below is a table showing all borers and parasites, including two species of hymenopterons obtained in 12 days from three different fields. No account was taken of the borer pupae and fly puparia from which adults had emerged, or borers and parasites killed by accident while splitting open the corn stalks. The percentages given are therefore merely approximate, and represent parasitism apparent only at the times of the examinations.

[2]A young sugar cane plant killed by a borer larva is called a "dead heart" because the central part of the plant, or "heart" dies first. These plants often have the outer leaves normally green, while the inner leaves are dry and dead.

PARASITISM OF SUGAR-CANE MOTH BORER IN CORN

Date	Living Borers	Paratheresia puparia and larvae	Ipobracon cocoons (Hymenop.)	Bassus cocoons (Hymenop.)	Nematodes	% Parasitism by Paratheresia
Jan. 2..	62	38	4	–	1	36.19
Jan. 4..	167	39	9	–	–	18.13
Jan. 5..	178	40	4	3	–	17.77
Jan. 8..	177	46	1	2	1	20.26
Jan. 9..	309	64	5	2	1	16.79
Jan. 10.	163	41	–	–	–	20.09
Jan. 11.	336	125	–	–	1	27.05
Jan. 12.	487	273	1	4	–	35.68
Jan. 14.	234	201	6	1	–	45.47
Jan. 15.	477	217	2	3	–	31.04
Jan. 16.	237	233	9	2	–	48.44
Jan. 17.	272	143	5	7	–	33.48
	3099	1460	46	24	4	
Average of percentages						29.11

The fields varied considerably in the infestation of the borer and in the abundance of parasites. Some fields examined during the months of February and March had become almost ripe before they were cut, and often in such cases the number of borers present were very few, and if compared with the good puparia present the percentage of parasitism ran up to 80 or 90. The number of fly puparia from which adults had emerged also increased with the age of the corn, and old dried fields, or those containing ripened corn, contained practically nothing but empty parasite and borer pupae cases. From a field at Moncada, Peru, where a large number of puparia were obtained, 100 stalks of corn were examined. These 100 stalks had 75 good borers or borer pupae and 70 fly puparia or borers showing signs of parasitism, or a total of 48% parasitism. This no doubt would be higher if the 75 good borers had been kept until the parasites within them developed. Still other fields contained a very small number of parasites.

In certain fields where parasitism was high, a number of borers were found which contained two fly maggots. These would produce two good sized puparia if the host were of large size, but if small, they would give two small puparia. Three puparia have been found at times next to each other and appeared to be formed from one host, but not more than two maggots have been seen within a host.

From a little over 500 borer pupae collected, 15 fly puparia were obtained, or about 3%. The parasite larvae had no doubt been in the borer when it changed into the pupa stage.

In order to get some idea of how freshly formed puparia withstand cold storage compared with older puparia, 12 light colored or reddish puparia

and 12 dark or black puparia were selected from those obtained in corn on February 28th, 1928. Two light colored puparia were examined and found to contain pupae that were in the early stages of development, while the two dark ones contained pupae that were in the final form. The twenty remaining puparia were then placed in an ice-box having a temperature between 42° and 50°F. for one month, or until April 2nd. They were then put in plaster of Paris vials set on moist sand in the office. From the ten dark colored puparia, five flies or 50% emerged between April 11th and 22nd. From the ten light colored puparia, six flies or 60% emerged between April 19th and 22nd. The puparia were taken directly from the ice-box and put in vials on April 2nd, and the temperature of the room at the time was 75°F. The room temperature recorded during this time shows a maximum of 83°F. and a minimum of 61°F. with average maximum of 75.1°F. and average minimum of 68.3°F. the average mean temperature being 71.7°F. This indicates that the puparia can stand cold storage for a period of at least one month and still give 50% emergence, though it is admitted that these data are very meager. But from emergence obtained from material shipped to New Orleans, Louisiana, it was learned that the longer the period of cold storage, the less the emergence.

The following results are noted for the cooler months of the year concerning the length of period spent in the puparium. From 50 puparia that were formed on June 24th and 25th from full grown larvae collected in corn on June 23rd, at Cartavio, Peru, two flies emerged on the 1st of August, eight on the 2nd, and the rest followed within the next few days. Thus the pupal period was from 37 to 44 days. The temperature for the month of July was from 51.8°F. to 78.8°F. with an average minimum of 57.56°F., an average maximum of 71.06°F., and an average mean temperature of 64.31°F. The temperature in June was very little higher.

The efficiency of this parasite is greatly reduced by the fact that it is attacked in the puparium by secondaries. These secondaries were found only on rare occasions in Tucumán during the year reported upon. In Peru, however, the parasitism by secondaries was found to run as high as 14% in one lot of puparia. The species from Peru have not as yet been determined but two species have been determined from Tucumán; one as *Spilomicrus* sp. of the family *Diapriidae*, and the other as *Pachycrepoideus dubius* Ashm. of the family *Sphegegasterinae*.

The number of puparia sent from Argentina between January 24th and April 18th amounted to 7,146, while from Peru 27,754 were sent in June and July. The puparia were packed in damp sphagnum moss in

small tin boxes, a number of these boxes being packed in a strong wooden box about 12 by 9 by 7 inches. All shipments were sent by cold storage, the wooden boxes being placed in small ice-boxes from point of collection to steamship. On board they were placed in the vegetable room of the ship at a temperature usually between 36° and 40°F. The boats were met in New York and the parasites were sent by train in another ice-box from New York to New Orleans. As has been stated, the longer the puparia were kept in cold storage the less emergence was obtained. Shipments from Tucumán, Argentina, were en route about four weeks, while those from Salaverry, Peru, arrived after fifteen days. From one shipment from Peru Mr. T. E. Holloway has reported nearly 46% emergence.

This parasite, *Paratheresia claripalpis* Van der Wulp, can be obtained in large enough numbers both in Argentina and Peru to make shipments from which the emergence will be worthwhile if the puparia are not kept too long in cold storage.

Literature Cited

1. Box, H. E. On the Identity of the Common Dipterous Parasite of the Larva of *Diatraea saccharalis* Fabr. in the Northern Provinces of Argentina. Bull. Ent. Research, Vol. 20, Pt. 2, pp. 199–200. 1929.
2. Bréthes, Juan. Parasites and Hyperparasites of Diatraea saccharalis in Tucumán Sugar Cane. Bull. Ent. Research, Vol. 18, Pt. 2, pp. 205–207. 1927.
3. Townsend, C. H. T. New Masiceratidae and Dexiidae from South America. Jour. N. Y. Ent. Soc., Vol. 23, p. 65. 1915.
4. ——— Informe sobre Las Plagas de La Caña en Los Valles de La Costa Peruana. Revista de Agricultura y Ganaderia, Vol. 3, No. 32 pp. 661–666. 1926.

RECENT EXPERIMENTS WITH SOIL ANIMALS ATTACKING ROOTS OF SUGARCANE

By Herbert Spencer and Charles L. Stracener, *The Louisiana Experiment Station*[1]

Abstract

During 1929, the growth of sugarcane grown in large cylinders containing sterilized or unsterilized soil, and inoculated with soil animals, or the fungus *Pythium*, or both *Pythium* and soil animals was affected adversely by the activities of these biological factors. They reduced the weight of cane, length of cane, and sucrose content.

Confirmatory evidence was obtained, that the Collembolans, *Lepidocyrtus violentus* Fols. and *Onychiurus armatus* Tull., and the Symphylid, *Symphylella* sp. "pit" the roots and eat away the small feeding rootlets.

Lepidocyrtus and *Onychiurus* were found responsible for part of the unsatisfactory germination of planted sugarcane, by destructive feeding on the "eyes" (buds).

[1]Published by permission of the Director, Louisiana Experiment Station.

"Growth Failure" or "Root Rot" of sugarcane is characterized by unthrifty, stunted growth of the plants, and "pitting" and rotting away of the root system to such a degree that stools may be pulled out of the ground with little effort. Fields of cane affected in this manner are unproductive and unprofitable. The condition of "growth failure" is brought about by the activities of a group of biological factors, including fungi (*Pythium*) (1)[2] and certain soil animals (the Collembolans, *Lepidocyrtus violentus* Fols., *Onychiurus armatus* Tull. and the Smyphylid *Symphylella* sp.). Laboratory and greenhouse experiments by the authors, previously reported (2), indicate that the Collembolan, *Lepidocyrtus violentus* Fols. is largely responsible for "root pitting" and "root pruning" and also indirectly for some of the stunting of the parts above ground. *Onychiurus* and *Symphylella* damage the roots to a lesser extent.

TABLE 1. SOIL ANIMAL FIELD TESTS, 1929

Group	Number Cylinders	Treatment (Each cylinder)
	Series I—Sterilized Soil	
1	7	none
2	5	*Pythium* added
3	5	*Pythium* 200 *Lepidocyrtus violentus* 200 *Onychiurus armatus* 200 *Symphylella* sp.
4	6	200 *Lepidocyrtus violentus* 200 *Onychiurus armatus* 200 *Symphylella* sp.
5	6	200 *Lepidocyrtus violentus*
6	6	200 *Onychiurus armatus*
7	6	200 *Symphylella* sp.
	Series II—Unsterilized Field Soil	
8	7	none
	Series III—Air-dried Field Soil	
9	2	none
10	3	200 *Lepidocyrtus violentus*
11	2	200 *Onychiurus armatus*
12	2	200 *Symphylella* sp.

However, it was considered advisable to confirm these results by studying these soil animals, and also *Pythium* under controlled conditions in sugarcane fields, so the following tests were planned and executed cooperatively by the Entomologists and Plant Pathologists of the Experiment Station:

Sheets of 28 gauge galvanized flat iron, 24 inches by 96 inches, were crimped and the ends riveted together to form cylinders with open ends.

[2]Numbers refer to literature cited on page 684.

Holes were dug in a sugarcane field to receive these cylinders, so that they were six feet apart, center to center, and so that six inches of the metal stood up above the ground level. Forty-one of these cylinders (Series I) were filled with sterilized field soil, seven (Series II) with unsterilized field soil, and nine (Series III) with air-dried field soil. Each cylinder was planted during October 1928 with sugarcane of the variety P. O. J. 213. The soil animals were placed in certain of these cylinders, other cylinders were inoculated with cultures of the fungus, *Pythium*, others received both *Pythium* and soil animals, and others were left uninoculated, for comparison.

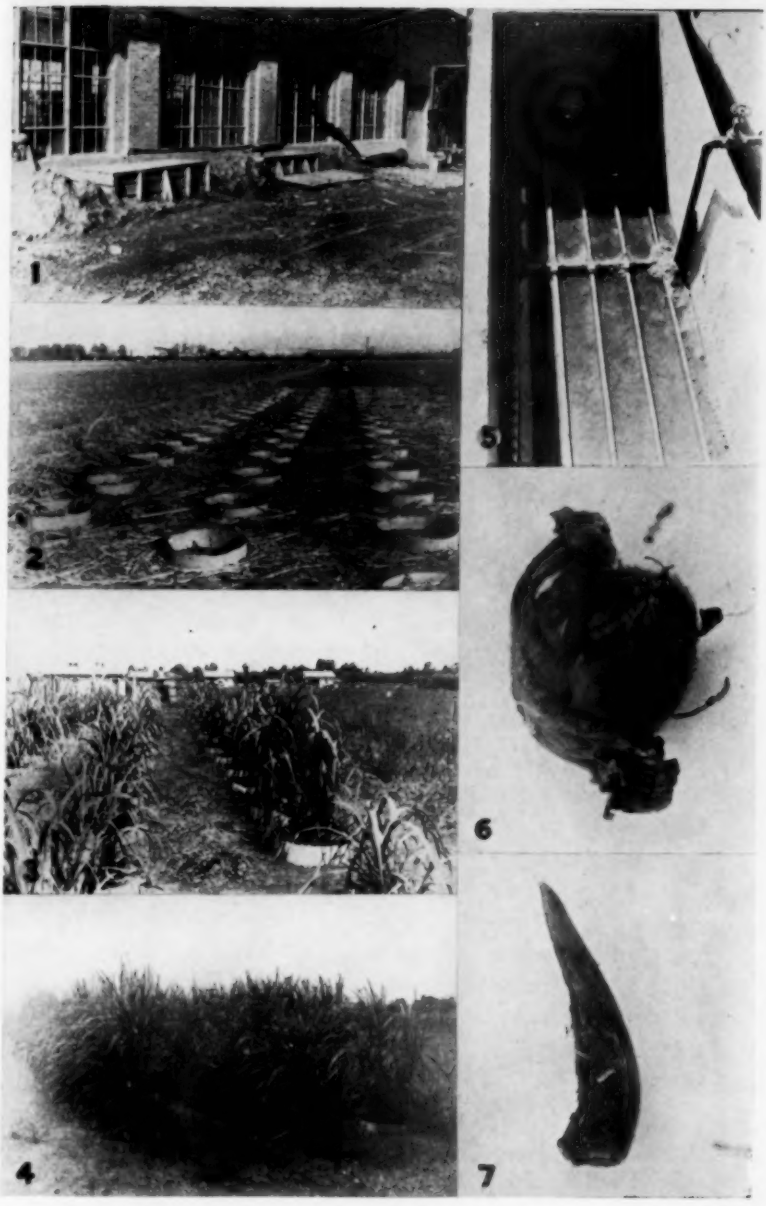
For sterilizing the soil two large boxes were constructed, were lined with sheets of galvanized flat iron, and were fitted with perforated galvanized iron pipes in the bottoms (Pl. 22, figs. 1, 5). Through these perforated pipes, live steam at 100 pounds pressure was forced into the soil, which in fifteen minutes reached temperatures above 95° C. The steaming was kept up for 1½ or 2 hours, and the soil was handled subsequently with steam sterilized shovels, and was placed in the cylinders while still very hot.

In the early spring, the sugarcane sprouted to a satisfactory stand in all but one of the cylinders. After "stooling-out," the number of canes per cylinder averaged more than twenty. During the growing season measurements of growth were made at monthly intervals, and in December the canes were cut, were weighed, and sucrose analyses were obtained. The final measurements and results are tabulated in the following table:

TABLE 2. SOIL ANIMAL FIELD TESTS, 1929, FINAL MEASUREMENTS

Group	Treatment	Average Sucrose	Growth Ratios Length	Weight
	Series I—Sterilized Soil			
1	none	13.27	100%	100%
2	*Pythium*	12.96	89%	98%
3	*Pythium* and Soil Animals	12.49	86%	89%
4	Soil Animals	12.99	87%	82%
5	*Lepidocyrtus*	13.33	84%	78%
6	*Onychiurus*	12.85	87%	84%
7	*Symphylella*	13.24	100%	95%
	Series II—Unsterilized Field Soil			
8	none	11.41	52%	41%
	Series III—Air-dried Field Soil			
9	none	11.94	75%	60%
10	*Lepidocyrtus*	11.89	77%	64%
11	*Onychiurus**	10.19	61%	44%
12	*Symphylella*	12.39	78%	64%

*One cylinder replanted.



1—Boxes for the steam sterilization of soil· 2—Cylinders of sterilized soil, in which sugarcane has been planted; 3—Half-grown sugarcane in soil cylinders; 4—Nearly mature sugarcane in the soil cylinders; 5—Inside of soil sterilizing box, showing arrangement of perforated steam pipes; 6—Bud from planted sugarcane; the center eaten by Collembolans, *Onychiurus armatus* Tull. Germination is prevented by such injury; 7—Bud scale showing springtail injury and two specimens of *Onychiurus*.

The cylinder in which the sugarcane failed to germinate (in Series III, Group 11) was examined carefully during May. When the seed pieces of sugarcane were dug it was discovered that the "eyes" (buds) had been eaten by the springtails, *Onychiurus* to such an extent that they could not sprout (Pl. 22, figs. 6, 7). *Onychiurus* individuals were found inside of the buds, actually at work eating the green portions of the bud scales. This discovery led to bud examinations in several districts where the germination was unsatisfactory; planted cane was dug, and the findings tabulated:

TABLE 3. SUGARCANE BUD INJURY BY INSECTS

Locality Louisiana	Buds Examined	Buds Uninjured	Buds Rotted by Fungi	Buds Attacked by Insects	% Buds Attacked by Insects
Baton Rouge..	778	71	211	496	63%
McCall.....	2586	102	1429	1044	40%

TABLE 4. INSECTS FOUND IN INJURED SUGARCANE BUDS

Total number of Insects	122
Onychiurus armatus Tull	56
Lepidocyrtus violentus Fols	26
Fly larvae	8
Termites	3
Miscellaneous (scavengers mostly)	29

The possibility of attack by the springtails being secondary to processes of decomposition was carefully considered and efforts were made to determine the true relation of causal agent to injury in every bud examined. The conclusion was reached that the springtails were primary agents, and that various rots, fly maggots and scavengers followed the springtails, doing further damage.

The writers wish to express their appreciation of the cooperation of Dr. C. W. Edgerton, Dr. E. C. Tims and other members of the Department of Plant Pathology, Louisiana Experiment Station.

SUMMARY

Under controlled conditions in a sugarcane field, with cane grown in large cylinders, the soil animals *Lepidocyrtus violentus* Fols., *Onychiurus armatus* Tull. and *Symphylella* sp., working together, caused a marked reduction in growth and final weight and a slight reduction in percentage of sucrose.

Sugarcane in cylinders inoculated with the fungus *Pythium* was affected similarly, and to approximately the same extent.

The growth and yield of sugarcane in cylinders inoculated with both *Pythium* and the soil animals was poorer.

Of the three soil animals, *Lepidocyrtus violentus* was the most injurious, *Onychiurus armatus* next, while very little damage could be attributed to *Symphylella*. The two springtails were found capable of affecting germination adversely, by eating portions of the buds and bud scales.

LITERATURE CITED

1. EDGERTON, C. W. and E. C. TIMS. Investigations on the Sugar Cane Disease Situation in 1925 and 1926. La. Experiment Station Bulletin 169. 1927.
2. SPENCER, HERBERT and CHAS. L. STRACENER. Soil Animals Injurious to Sugarcane Roots. Annals of Entomological Society of America—XXII, No. 4; 641–649. 1929.

THE VELVET BEAN CATERPILLAR AS A PEST OF SOY BEANS IN SOUTHERN LOUISIANA AND TEXAS[1]

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ABSTRACT

An attack on soy beans by the velvet bean caterpillar, *Anticarsia gemmatilis*, is reported, together with observations on the life history, natural enemies, and control measures. The application of a "light" or eighty per cent brand of sodium fluosilicate was found to be very effective in destroying the larvae.

Soy beans are grown throughout southern Louisiana, parts of Texas, and elsewhere, as a forage crop, and as a valuable legume in rotation with rice and other crops. The plants are also sometimes turned under in the fall as green manure, or cut and dried for feeding during the winter months.

The most serious insect pest found on soy beans in Louisiana prior to 1929 was the striped blister beetle.[2] Adults of this species appear most abundantly during July and August, and can be successfully controlled by applications of sodium fluosilicate as recommended by J. W. Ingram in U. S. Department of Agriculture Leaflet No. 12. The insect on soy beans attracting most attention during 1929 was what is known as the velvet bean caterpillar,[3] and it was found possible to control it by the use of the same chemical. As a similar infestation may recur in future years, it seems desirable to publish the information now available.

[1]The results here recorded were first published in a brief and popular manner in the Rice Journal of Crowley, Louisiana, in the number for December, 1929. This was published in the last part of November, 1929.

[2]*Epicauta lemniscata* Fab.; order Coleoptera, family Meloidae.

[3]*Anticarsia gemmatilis* Hübner; order Lepidoptera, family Noctuidae.

TYPE OF INJURY. The larvae of this night-flying moth are hearty feeders. They begin feeding on the tender leaves near the top of the plant. After the top leaves have been destroyed, the older leaves near the bottom of the plant are devoured. Still further, when all the leaves have been eaten, the tender parts of the stems are eaten away. Where a heavy infestation occurs, the larvae hollow out the ends of the stems, eat the buds from the stalks, chew off the branches and small bean pods completely, and sometimes gnaw the outside wall from the main stalk. The plants are, of course, ultimately killed.

FOOD PLANTS. In southern Louisiana, in 1929, the larvae fed only on soy bean plants, except for occasional slight feeding on cotton. After the green, tender parts of soy beans had been totally destroyed, the larvae marched into neighboring cotton fields and fed slightly. Pupae were found in cotton fields only where the cotton was grown very near to soy beans and after the soy beans had been completely denuded. The most "viney" varieties of beans were preferred by the larvae. It is thought by the writer that this was due to the fact that the stems and leaves of the "viney" varieties are more succulent, that the moths find better hiding places in their luxuriant foliage, and that these varieties mature later than the other varieties. In every case the "viney" soy beans were infested first, but the infestation spread rapidly to all other varieties. Careful observations were made in the fields where cotton and soy beans, kudzu vine (wild) and soy beans, cowpeas and soy beans, and velvet beans and soy beans were growing side by side or very near each other. No feeding or specimens could be detected on any of these crops other than soy beans except on cotton as mentioned. No kind of grass or weed was attacked whether growing in soy bean fields or elsewhere. In Florida, however, Watson[4] records velvet beans, kudzu vine, and horse beans as food plants.

DISTRIBUTION. This insect does not survive the winter in the United States except possibly in extreme southern Florida, according to Watson, who states that the moths migrate northward "each summer from the southern end of the peninsula or perhaps from Cuba." In the summer of 1929, the insect was widely distributed over southern Louisiana and southeastern Texas. The first infestations were noted near Napoleonville and New Iberia, La., about the middle of August. By the middle of September the infestation had moved westward approximately 250 miles by way of Lafayette, Crowley, Jennings, and Lake Charles, La.,

[4]Watson, J. R. Control of the Velvet Bean Caterpillar. University of Florida Agricultural Experiment Station Bulletin No. 130, pp. 45–58, 9 figs., 1916.

and Beaumont, Texas, to the vicinity of Nome, Texas, which is about 15 or 20 miles west of Beaumont. The infestation ranged some 8 or 10 miles south of the more or less parallel east and west line. These larvae have been reported as far north as Colfax, La., which is near the center of the State.

This infestation was the first in Louisiana to be serious enough to attract the attention of entomologists. In previous years, during the late fall, caterpillars of some kind have injured the foliage of soy beans very slightly, but there is no evidence to show that *Anticarsia gemmatilis* was responsible for the injury.

LIFE HISTORY. The adult of the velvet bean caterpillar, which is a dirty-brown moth, made its appearance in southern Louisiana about the middle of August. The moths, when disturbed, have a very swift flight. It is extremely difficult to see them when they are resting close to the soil as at this time the wings are opened in a position almost at right angles to the thorax and the body is pressed to the earth.

The moths usually deposit eggs singly on the under side of the leaves, but eggs are sometimes deposited on the upper side. Often only one egg can be found on a single plant, and again single eggs may be found on several leaves of a plant.

The eggs hatch in from three to five days. The larvae feed on the soy bean leaves for about three weeks. They actually spring into the air and throw themselves about when disturbed, and can be recognized by the general colorings and lines of the body as described on another page. When these caterpillars are handled they eject a brownish yellow fluid from the mouth.

When fully grown, they usually fall to the ground, burrow underneath the surface, and pupate. A small percentage of the larvae pupate on the plants, pulling together the sides of the leaves so as to form pupation inclosures, but this happens only in the lesser infestations. In heavy infestations no leaves are left available on the plants for pupation inclosures and all of the larvae pupate in the soil. A cell of earth is constructed at a depth of from one-fourth inch to 2 inches under the surface of the soil, and here the pupation period is spent. As many as 22 pupae were found in 1 square foot of soil in the Crowley section of southern Louisiana during 1929, when the average number of pupae per square foot in that section was found to be 13. Around New Iberia, La., the infestation was at least as heavy. Moths emerge from the pupae during the latter part of August and the early part of September, in from 6 to 10 days after pupation.

In Southern Louisiana, three distinct generations occurred in 1929. However, moths in migration continually deposited eggs, and young larvae from these could be found mixed with the older larvae at all times until the soy beans had been destroyed.

The first observed injury from larvae occurred about the middle of August. Moths from the first brood of larvae had emerged and were ready to lay eggs by the second week in September.[5]

DESCRIPTION. The egg, which is white, is slightly oval, from 1 to 1½ millimeters in greatest diameter, and has a rather shiny appearance. Eggs are deposited singly on the leaves of the food plants.

The larva reaches an average length of 37 millimeters, or about 1½ inches. The markings vary. The ground color of the larva is black or nearly black, except that some specimens have a grass-green color instead of black. Dark stripes alternate with lighter and even with white ones, and run the full length of the body. A stripe in the middle of the back, or dorsal surface, is always light, usually of a light green. This is bordered on each side with a broad dark stripe. From this to the ventral surface there may be one light stripe, or three light stripes alternating with dark ones. In the latter case the narrow dark stripe nearest the ventral surface is light brown. Spots around the setae, or hairs, are not prominent, but they are still darker than the dark stripes. The ventral or under surface is never striped and is always dark. The legs are lighter in shade than the rest of the ventral surface. Specimens in alcohol have a greenish instead of a black appearance.

The pupa averages 18 millimeters or about three-fourths inch in length. It is dark brown.

The moths average 37 millimeters or about 1½ inches across the outstretched wings and 12 millimeters or about one-half inch from head

[5]The following data on temperature, humidity and rainfall at Crowley, La., will indicate the weather conditions for the period during which the insect was most injurious.

For August, 1929, the average maximum temperature was 91.29°F., with 94°F. as the highest daily maximum. The average minimum was 72.29°F., with 63°F., as the lowest daily minimum. The average mean temperature was 81.79°F. The average relative humidity, according to wet and dry bulb readings, was 68.3 per cent. The rainfall was 2.87 inches, which included two rains of over an inch. Twelve days were more or less rainy, the other days being usually clear.

For September, 1929, the average maximum temperature was 87.86°F., with 93°F. as the highest daily maximum. The average minimum was 67.3°F., with 57°F, as the lowest daily minimum. The average mean temperature was 77.58°F. The average relative humidity was 65.8 per cent. The rainfall was 2.40 inches, 11 days being more or less rainy, but the heaviest rain being only 0.54 inch. The other days of the month were usually clear.

to end of abdomen. They are grayish brown, although through a hand lens the wings have a peppered appearance, black specks showing on a lighter surface. A line, which may be either lighter or darker than the rest of the wing, extends from wing tip to wing tip, running half way up the wings so as to form a segment of a circle when the moth is at rest, with the wings arranged fan shaped. This line, which is about a fourth of a millimeter in width, may be edged on each side with a parallel line which is lighter in color. The part of the wing on the caudal side of this line is of a darker brown than is the side nearest the head. Just below the line, and near the abdomen, there are two black dots on each wing. These are edged caudad, or toward the rear, with yellow, another sprinkling of black sometimes appearing caudad of the dash of yellow. The wings are bordered with a brown or yellow line, and are heavily fringed with gray or brown. On the under side of the wings is a row of white dots, consisting of seven dots to each wing. The row of dots appear about 2 millimeters or a twelfth of an inch from the caudal end of the wings.

NATURAL ENEMIES. The most effective natural enemies in southern Louisiana are birds. In fields, especially near the marshes and in the rice section of Louisiana, great flocks of birds congregate. The most numerous is the upland plover,[6] which is gray with a touch of white at the throat. It is very wild upon arrival in the fields but grows tamer if protected. It is possible sometimes to walk within 20 feet of this bird without disturbing it. It is often called "papabot" and sometimes "cherou." The "rice bird," or redwinged blackbird,[7] the English sparrow,[8] and the killdeer[9] have also been found by the writer to consume large numbers of the larvae. Other birds recorded[10] as enemies of the velvet bean caterpillar, although not observed by the writer, are the bobolink,[11] field sparrow,[12] and mockingbird.[13]

Young bullfrogs have been seen to catch the larvae and eat them until sometimes they get so full that they look as if a pressure pump was responsible for their inflated condition.

Such insects as wasps, robber flies, various Hemiptera, ground beetles, and fire ants feed very readily upon the larvae. On several occasions the writer has observed a thread-waisted wasp, *Sphex pictipennis* (Walsh), capturing larvae. Owing to the violent movements of the

[6] *Bartramia longicauda* (Beckstein).

[7] *Agelaius phoeniceus* (L.) [8] *Passer domesticus* (L.) [9] *Oxyechus vociferus* (L.)

[10] Watson, J. R. University of Florida Agr. Expt. Sta. Bul. 130, p. 56, June, 1911, and Jour. Econ. Ent. 9, pp. 526–527, December, 1916.

[11] *Dolichonyx oryzivorus* (L.) [12] *Spizella pusilla* (Wilson). [13] *Mimus polyglottos* (L.)

caterpillars when any object approaches them, this wasp did not fly directly to a caterpillar, but first alighted on the plant and then decided what larva to attack. It then flew to a leaf above the chosen caterpillar, opened its mandibles wide, and made a flying tackle on the larva and they both fell to the ground in a terrific struggle. The wasp was invariably victorious and soon began to climb up some object in order to get a flying start to carry its huge load away.

So far as is known at this writing, the only true parasite of *Anticarsia gemmatilis* is a small hymenopterous insect. It is not known whether this parasite attacks the larva or the pupa, but it emerges from the pupa. It has been determined by Miss Grace A. Sandhouse as *Brachymeria ovata* (Say).

A fungus disease[14] is sometimes a valuable factor in controlling outbreaks of this insect. One field in Iberia Parish, Louisiana, was completely freed of the caterpillars by this disease. The dead larvae often hang to the branches and leaves and have a greenish white appearance. It is not safe to rely upon this disease to save a soy-bean crop, because the plants may be severely and sometimes fatally injured before the fungus gets a start.

EXPERIMENTS IN CONTROL. The following experiments were conducted on soy beans at the Rice Experiment Station, Crowley, La., and acknowledgment is made to Mr. J. M. Jenkins, Superintendent, Rice Experiment Station, for his suggestions and cooperation in trying out the different control measures.

Owing to the very delicate nature of soy-bean leaves, it was something of a problem to find a poison which would kill the caterpillars without harming the plants. Experiments were conducted with calcium arsenate as a dust and with lead arsenate as a spray. The infestation appeared so suddenly that only these two insecticides, which were all that were available locally, could be tested. When the caterpillars eat leaves treated with arsenicals they of course die, but because of the fact that arsenicals kill soy beans, their use results as injuriously, in most cases, as the defoliation caused by the insect. As much as 5 per cent of lime was mixed with calcium arsenate, but very serious burning still occurred.

A standard nicotine spray was tried and, although no burning resulted, there was a very low percentage of kill. The addition of soap to the spray did not cause enough to adhere to the leaves to give good results.

Pure hydrated lime was used as a dust with no success.

[14] *Botrytis rileyi.*

Poisoned bran mash was used experimentally and gave a very low percentage of kill. Both wheat bran and alfalfa meal were used as ingredients of the mash, but neither gave promising results.

Since the soy-bean plants are able to withstand floods, it was thought that possibly the soil might be flooded and the pupae drowned. According to J. M. Jenkins, these plants are not injured by water standing over the soil for a period of 48 hours. Plots consisting of several acres were flooded for 48 hours and the pupae examined were found to be still alive and apparently not injured by the water.

Undiluted sodium fluosilicate of the brand sold by manufacturers as "light," which is from 80 to 84 per cent pure, has given excellent results when dusted on the plants at the rate of 10 to 12 pounds to the acre. The percentage of kill in every case has been from 90 to 100 per cent, more frequently 100 per cent. The larvae die in less than 24 hours after application.

Mixtures of 1 part hydrated lime to 4 parts of sodium fluosilicate, and 1 part of hydrated lime to 7 parts sodium fluosilicate were not satisfactory.

From preliminary experiments, it appears that the moths are attracted very little to lights.

Recommendations

1. Dust infested fields with sodium fluosilicate, preferably a "light" or 80 per cent brand. The lighter brands give as satisfactory results as do the heavier brands and are more economical to use. A hand duster, such as is used for dusting small plats of cotton, is satisfactory.

This dust should be applied at the rate of from 10 to 12 pounds per acre on medium sized soy beans. The dust should be applied on plants which are dry, as slight burning occurs when dust is applied on wet plants. A second application may be necessary about ten days after the first, if enough rain has fallen to wash the dust off the plants, if the field has another infestation from eggs hatching, or if larvae are migrating from neighboring fields. The caterpillars eat the dust on the plants and die. Some of them fall to the ground, while others hang to the plant. The dead larvae turn black and shrivel up. A rain that falls soon after dusting does not prevent the killing of larvae then present, but renders the dust less effective for the larvae which appear several days later.

2. A cultivation of soy beans soon after the larvae begin pupating has been found to kill a number of pupae.

3. When soy beans are planted for hay it is advisable to cut the crop as soon as these caterpillars appear, but where planted for seed production the soy beans should be dusted as soon as the first signs of larvae are noticed.

RELATIVE EFFECTS OF BORDEAUX MIXTURE AND OF HYDRATED LIME ON ARSENICAL SPRAYS IN THE CONTROL OF THE PECAN LEAF CASE-BEARER

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ABSTRACT

Bordeaux mixture and hydrated lime were tested to determine their relative effectiveness as correctives for arsenical injury to pecan foliage. Bordeaux mixture proved to be effective in preventing arsenical injury whereas hydrated lime did not, when the latter was used at the same strength as in the fungicide. When acid lead arsenate and Paris green were used separately in combination with Bordeaux mixture and at strengths at which they contained approximately the same quantity of metallic arsenic, the Paris green-Bordeaux mixture was the more effective against the pecan leaf case-bearer. Commercial calcium arsenate in combination with Bordeaux mixture, when the arsenical was used at a strength at which it contained more metallic arsenic than did either the acid lead arsenate or the Paris green as used in combination with Bordeaux mixture, gave insecticidal results nearly comparable to those of the Paris green-Bordeaux mixture combination. Commercial calcium arsenate in combination with Bordeaux mixture appeared much more effective in the control of the pecan leaf case-bearer than was acid lead arsenate in combination with Bordeaux mixture, when the same poundage of each arsenical was used. Furthermore, the cost of the calcium arsenate in the Bordeaux mixture was only about one-half that of the acid lead arsenate.

Severe foliage injury, amounting at times to almost complete defoliation, has occasionally resulted from the application of arsenical sprays to pecan foliage. Hydrated lime has been used successfully, in some instances, to eliminate foliage injury from acid lead arsenate ($PbHAsO_4$), the form generally used in spraying pecan trees for certain insects. However, many instances of severe injury to pecan foliage have occurred when the acid lead arsenate-hydrated lime combination has been used. During experimental work in 1927 and 1928, the writer observed that whenever Bordeaux mixture was combined with acid lead arsenate, no arsenical injury to pecan foliage occurred. In 1929, experiments were conducted to determine (1) the relative effects of Bordeaux mixture and of hydrated lime as correctives for arsenical injury, (2) the relative inhibiting action of Bordeaux mixture on the effectiveness of various arsenicals, and (3) whether an arsenical that is cheaper than acid lead arsenate could be employed effectively with this fungicide in the control of the pecan leaf case-bearer, *Acrobasis palliolella* Rag.

FIELD SPRAYING EXPERIMENTS IN 1929. To determine the relative effects of various combination sprays as to foliage injury and insecticidal efficiency under field conditions, a block of 260 pecan trees divided into plats of 20 trees each was used. The block consisted of the Schley variety, and the trees were 13 years of age and averaged from 25 to 35

feet in height. A careful examination of the trees showed that the infestation of the pecan leaf case-bearer was quite uniform throughout the block before the sprays were applied. The spraying was done with a large-capacity outfit equipped with a pump capable of discharging 25 gallons per minute. A pressure of 250 pounds was maintained during the tests. Two leads of hose were used, one operator spraying from the top of the spray tank with a large special pecan gun (with a disc aperture of ¼ inch) attached to 20 feet of ¾-inch hose, and the other operator spraying from the ground with an ordinary orchard spray gun (with a disc aperture of ⅛-inch) attached to 50 feet of ½-inch hose. The average quantity of liquid used per tree was 12 gallons.

In Tables 1 and 2 will be found data as to the experiments. In all the tests, except in plats 3 and 4, hydrated lime (analyzing approximately 73 per cent calcium oxide) was used in the same proportion. In plats 3 and 4 the Bordeaux mixture was more dilute and hence the quantities of lime in the sprays were smaller. In the combination sprays in plats 5 and 10 inclusive, Bordeaux mixture of the formula 3–5–50, employing pulverized copper sulphate and hydrated lime, was used. Plats 3 and 4 received sprays in which the quantities of Bordeaux mixture, and therefore of both copper sulphate and hydrated lime, in the combination were smaller. In plats 2 and 7 fish oil of "choice light pressed" grade, and in plat 8 calcium caseinate, were incorporated in the combinations used. This was done to ascertain whether or not spreaders would tend to promote foliage injury.

Acid lead arsenate and Paris green were used throughout the tests at strengths at which the quantities of metallic arsenic contained in them were approximately the same, whereas the commercial calcium arsenate was used at a strength at which it contained somewhat more metallic arsenic. As commercial calcium arsenate is considerably cheaper than acid lead arsenate or Paris green, it was assumed that if commercial calcium arsenate was used in the combination spray at the rate of 1 pound to 50 gallons and produced equal or better results than did the acid lead arsenate when used in the combination at the rate of 1 pound, or Paris green at the rate of one-half pound to 50 gallons, it would be immaterial whether the arsenic content of the arsenicals was the same or not. The commercial calcium arsenate used contained 45.15 per cent of arsenic oxide (As_2O_5) and 38.16 per cent of calcium oxide (CaO). Acid lead arsenate and Paris green are well standardized and generally contain about 30 per cent of arsenic oxide (As_2O_5) and 50 per cent of arsenious oxide (As_2O_3) respectively.

TABLE 1. ARSENICAL INJURY TO PECAN FOLIAGE CAUSED BY SPRAY COMBINATIONS, 1929

Plat No.	Combination spray and rate of application	Date of application	Date leaf injury first observed	Final leaf injury	Defoliation
1	Acid lead arsenate 1 lb., hydrated lime 5 lbs. to 50 gals. water	Aug. 5	Aug. 14	Severe	Partial
2	Acid lead arsenate 1 lb., hydrated lime 5 lbs. fish oil 1 pt. to 50 gals. water	Aug. 5	Aug. 14	Severe	Partial
3	Acid lead arsenate 1 lb. to 50 gals. ¾–1¼–50 Bordeaux mixture	Aug. 5	Aug. 30	Slight	None
4	Acid lead arsenate 1 lb. to 50 gals. 1½–2½–50 Bordeaux mixture	Aug. 5	———	None	None
5–6	Acid lead arsenate 1 lb. to 50 gals. 3–5–50 Bordeaux mixture	Aug. 5	———	None	None
7	Acid lead arsenate 1 lb., fish oil 1 pt. to 50 gals. 3–5–50 Bordeaux mixture	Aug. 6	———	None	None
8	Acid lead arsenate 1 lb., calcium caseinate ½ lb. to 50 gals. 3–5–50 Bordeaux mixture	Aug. 6	———	None	None
9–10	Commercial calcium arsenate 1 lb. to 50 gals. 3–5–50 Bordeaux mixture	Aug. 5	———	None	None
11	Paris green ½ lb. to 50 gals. 3–5–50 Bordeaux mixture	Aug. 6	———	None	None
12	CHECK (1)	———	———	None	None
13	CHECK (2)	———	———	None	None

SPRAY INJURY. The results as recorded in Table 1 show that the acid lead arsenate-hydrated lime and the acid lead arsenate-fish oil-hydrated lime combinations (plats 1 and 2) caused considerable burning to pecan foliage and partial defoliation. A little more injury was noted in plat 2, where fish oil was used in the combination spray, than in plat 1. The injury to the foliage was first observed nine days after these combinations were applied. From August 5 and 6, when the applications were made, to the end of the month, frequent showers and occasional heavy dews occurred. In plat 3 where acid lead arsenate in combination with ¾–1¼–50 Bordeaux mixture was applied, slight foliage injury but no defoliation occurred. No injury resulted when acid lead arsenate was

used in combination with 1½–2½–50 Bordeaux mixture, as in plat 4. In plats 5, 6, 9, 10, and 11, where 3–5–50 Bordeaux mixture was used in combination with acid lead arsenate, commercial calcium arsenate, and Paris green, no foliage injury or defoliation occurred. In plats 7 and 8 the fish oil and calcium caseinate when added to Bordeaux mixture-arsenical combinations did not affect the combinations in such a way as to cause arsenical injury.

The results show that Bordeaux mixture 3–5–50 was far more effective as a corrective for arsenical injury to pecan foliage than hydrated lime used at the same strength as in the Bordeaux mixture.

PROBABLE REASONS FOR THE ACTION OF BORDEAUX MIXTURE IN PREVENTING ARSENICAL INJURY TO PECAN FOLIAGE. Not much investigational work on the chemistry of Bordeaux mixture-arsenical combinations, to determine why Bordeaux mixture prevents arsenical injury to foliage, appears to have been carried out. The probable reason for this is that if the action is chemical a more definite knowledge of the chemistry of Bordeaux mixture than is at present available would be required. According to Pickering (*1*) the copper salt present in Bordeaux mixture is a double basic sulphate of copper and calcium to which he has given the formula $(CuO)_{10}SO_3\ (CaO)_4SO_3$. When arsenicals are combined with Bordeaux mixture, this insoluble double basic sulphate of copper and calcium may act in one of two ways in preventing arsenical injury, (1) by absorbing soluble arsenic or (2) by combining chemically with it.

Fields and Elliott (*2*) reported that the quantity of arsenic in solutions decanted from different combinations of Bordeaux mixture with either acid lead arsenate or neutral lead arsenate is very small even after the solutions have stood two weeks.

Cook and McIndoo (*3*), employing a dried precipitate of Bordeaux mixture in combination with acid lead arsenate, calcium arsenate, sodium arsenate, and Paris green, found that the quantity of water-soluble arsenic in the combination was less than that in the arsenicals alone.

Goodwin and Martin (*4*) reported on results of experiments with glass wool and found that the addition of copper sulphate to lead arsenate-calcium hydroxide mixtures accomplished the removal or prevented the formation of soluble arsenic. They also stated that the addition of copper sulphate to dicalcium arsenate, basic calcium arsenate, or commercial calcium arsenate in combination with calcium hydroxide caused an enormous reduction in the soluble arsenic formed. When hydrated

lime alone was added to these arsenicals arsenic oxide (As_2O_5) in much larger quantities was produced in solution. They did not investigate the causes for the reduction in the quantity of arsenic in solution or attribute them to the action of the Bordeaux mixture. However, they said: "It may be that the action is more physical than chemical, and that the deposition of the basic copper compounds upon the particles of the arsenical may form a protective coating by which, in the case of the basic calcium arsenates, hydrolysis is retarded, or, in the case of the lead arsenate, the interaction with the lime is prevented." They reported, further, that an "equal lime" Bordeaux mixture containing an equivalent quantity of calcium hydroxide proved far more effective in reducing arsenical injury than the calcium hydroxide alone.

Sanders and Kelsall (*5*) reported that when calcium arsenate is used alone it may under some conditions burn foliage, but when used in combination sprays with Bordeaux mixture it is as safe as any known arsenical.

METHOD USED IN MAKING COUNTS FOR DETERMINING PERCENTAGES OF EFFECTIVENESS FOR THE VARIOUS COMBINATIONS TESTED AGAINST THE PECAN LEAF CASE-BEARER. In order to determine the effectiveness of the arsenicals in combinations tested against the pecan leaf case-bearer, it was found necessary to determine, after the pecan trees had lost their foliage in the fall, percentages of infested buds and hibernacula which had actually been formed on the current season's growth. The larvae of the pecan leaf case-bearer feed very sparingly over a period of several months during the summer and early fall. They do not mature before going into hibernation and attain an approximate average length of only 1/16 inch. After pecan foliage is sprayed it may take from a day to several weeks for individual larvae to reach the poison on the surface of the foliage under field conditions. Hence, it was found impossible to determine at just what period accurate counts could be made by examining the larvae on the foliage after applications, to determine the percentages of effectiveness for the various combinations. In addition, as the very tiny larvae feed from small tightly-woven spiral cases, it was found very difficult to dissect them, in order to determine effectively the values of the sprays, without injuring the larvae. Consequently counts were made of the infested buds, and of the hibernacula which formed on them, to arrive at percentages of control.

RELATIVE EFFECTIVENESS OF ARSENICALS WHEN COMBINED WITH BORDEAUX MIXTURE AND HYDRATED LIME AGAINST THE PECAN LEAF CASE-BEARER. Sanders and Brittain (*6*) found that fungicides inhibit

the action of arsenical sprays. Cook and McIndoo (*3*) reported that when lime or Bordeaux mixture was combined with arsenicals the toxicity of the arsenicals was reduced. They found that leaves sprayed with arsenicals combined with Bordeaux mixture usually contained less arsenic than those similarly sprayed with the arsenicals alone, and that the toxic effect was greater in tests with honeybees fed honey containing arsenicals alone than in tests in which bees ate honey containing arsenicals combined with lime or Bordeaux mixture. They found that the toxicity varied considerably depending on the species of insect, and that the addition of Bordeaux mixture to acid lead arsenate, to calcium arsenate, to sodium arsenate, and to zinc arsenite reduced the toxicities of these arsenicals to silkworms, webworms, and honeybees but reduced the toxicity to tent caterpillars little if any. Their analytical data show that the addition of hydrated lime to the arsenicals against all insects used reduced the toxic value of the arsenicals slightly more than did the addition of Bordeaux mixture.

By reference to Table 1 it will be seen that defoliation occurred in plats 1 and 2. Owing to the fact that considerable premature defoliation occurred in these plats where acid lead arsenate-hydrated lime and acid lead arsenate-fish oil-hydrated lime combinations were used before the larvae commenced to go into hibernation, the values secured (Table 2) can not be compared with those secured in the plats where the foliage was not impaired in any way by spray applications. In comparing the percentages of infested buds and of hibernacula which formed on the buds, better values were secured in plats 9 and 10, where commercial calcium arsenate-Bordeaux mixture was used, than in plats 5 and 6, which received acid lead arsenate-Bordeaux mixture, or in plat 7, which received acid lead arsenate-fish oil-Bordeaux mixture. That the commercial calcium arsenate-Bordeaux mixture was the more effective combination might be ascribed to the fact that when acid lead arsenate is combined with Bordeaux mixture, the excess lime reacts with the acid lead arsenate, producing basic calcium arsenate ($Ca_5(AsO_4)_3OH$ and basic lead arsenate ($Pb_4PbOH(AsO_4)_3$, the latter compound being much less toxic to insects generally than acid lead arsenate or calcium arsenate. It should also be considered that although the acid lead arsenate and commercial calcium arsenate were used on an equal poundage basis, the latter arsenical contained more metallic arsenic. On the other hand, commercial calcium arsenate, which contains an excess of lime, is not broken up or altered in any way by the action of Bordeaux mixture. In plat 11 the Paris green-Bordeaux mixture combination gave a value slightly better than where commercial calcium arsenate-Bordeaux mixture was used, as in plats 9 and 10.

TABLE 2. RELATIVE EFFECTIVENESS OF ARSENICALS

TABLE 2. RELATIVE EFFECTIVENESS OF ARSENICALS WHEN COMBINED WITH BORDEAUX MIXTURE AND HYDRATED LIME AGAINST THE PECAN LEAF CASE-BEARER 1929

Plat No.	Combination spray and rate of application	Date of application	Number of buds examined	Total number of infested buds	Total number of hibernacula formed on buds	Per cent infested buds	Number of hibernacula per 100 buds
1	Acid lead arsenate 1 lb., hydrated lime 5 lbs., to 50 gals. water	Aug. 5	4,125	13	16	0.31	0.38
2	Acid lead arsenate 1 lb., hydrated lime 5 lbs., fish oil 1 pt., to 50 gals. water	Aug. 5	4,066	37	53	0.90	1.30
3	Acid lead arsenate 1 lb. to 50 gals. ¾–1¼–50 Bordeaux mixture	Aug. 5	——	—	——	——	——
4	Acid lead arsenate 1 lb. to 50 gals. 1½–2½–50 Bordeaux mixture	Aug. 5	——	—	—	——	——
5	Acid lead arsenate 1 lb. to 50 gals. 3–5–50 Bordeaux mixture	Aug. 5	4,059	166	255	4.08	6.27
6	Acid lead arsenate 1 lb. to 50 gals. 3–5–50 Bordeaux mixture	Aug. 5	4,149	204	318	4.91	7.66
7	Acid lead arsenate 1 lb., fish oil 1 pt., to 50 gals. 3–5–50 Bordeaux mixture	Aug. 6	4,192	98	140	2.33	3.33
8	Acid lead arsenate 1 lb., calcium caseinate ½ lb., to 50 gals. 3–5–50 Bordeaux mixture	Aug. 6	——	—	—	——	——
9	Commercial calcium arsenate 1 lb. to 50 gals. 3–5–50 Bordeaux mixture	Aug. 5	4,000	20	25	0.50	0.62
10	Commercial calcium arsenate 1 lb. to 50 gals. 3–5–50 Bordeaux mixture	Aug. 5	3,979	49	58	1.23	1.45
11	Paris green ½ lb. to 50 gals. 3–5–50 Bordeaux mixture	Aug. 6	4,130	20	24	0.48	0.58
12	CHECK (1)	——	4,221	808	1,446	19.14	34.25
13	CHECK (2)	——	4,535	842	1,485	18.56	32.74

The differences between the percentages of hibernacula formed on the buds where commercial calcium arsenate or Paris green was used, and where, as in the checks, no sprays were applied, are significant and indicate that the Bordeaux mixture did not inhibit the action of these arsenicals to any appreciable extent if at all. In the case of acid lead arsenate the differences in percentages are more pronounced, owing possibly to the chemical changes which occurred when acid lead arsenate was combined with Bordeaux mixture as previously described. In Plat 7, where fish oil was used in combination with acid lead arsenate and Bordeaux mixture, the fish oil increased the effectiveness of the combination, as can be seen by a comparison with the results in Plats 5 and 6, although the difference in effectiveness was not sufficient to warrant incorporating fish oil in combinations where Bordeaux mixture is used.

Summary

Acid lead arsenate-hydrated lime and acid lead arsenate-fish oil-hydrated lime mixtures, under the conditions of the experiments, caused arsenical injury to pecan foliage and partial defoliation.

Acid lead arsenate in combination with ¾–1¼–50 Bordeaux mixture caused slight foliage injury and no defoliation, and the same arsenical when used with 1½–2½–50 Bordeaux mixture did not cause any foliage injury or defoliation.

Acid lead arsenate, commercial calcium arsenate, and Paris green, when combined with Bordeaux mixture 3–5–50, did not cause any foliage injury or defoliation.

Bordeaux mixture is a much better corrective for arsenical injury to pecan foliage than hydrated lime used at the same strength as in the fungicide.

No material advantage is gained in incorporating fish oil or calcium caseinate in combinations of Bordeaux mixture and arsenicals, as Bordeaux mixture, being colloidal in character, is a very good sticker and spreader for arsenicals.

A comparison of the percentages of hibernacula of the pecan leaf casebearer formed on the buds of pecan trees sprayed with commercial calcium arsenate or Paris green combined with Bordeaux mixture, with the percentages formed on trees in the untreated plats indicates clearly that Bordeaux mixture did not inhibit the action of the arsenicals to any appreciable degree if at all. The results secured where acid lead arsenate in combination with Bordeaux mixture was used are not so significant and indicate the probability that chemical changes occurred in the combination which influenced the results.

Commercial calcium arsenate in Bordeaux mixture, when the arsenical was used on the same poundage basis as acid lead arsenate in Bordeaux mixture, was considerably the more effective insecticide against the pecan leaf case-bearer.

Paris green in Bordeaux mixture, when used at a strength at which it contained approximately the same quantity of metallic arsenic as did the acid lead arsenate used in Bordeaux mixture, was more effective than the latter, and slightly more effective as compared with commercial calcium arsenate in Bordeaux mixture when the commercial calcium arsenate was used at a strength at which it contained more metallic arsenic.

Commercial calcium arsenate may be used in Bordeaux mixture at the same poundage as acid lead arsenate in Bordeaux mixture, with greater effectiveness, in the control of the pecan leaf case-bearer and with a saving in the cost of the arsenical of about one-half.

LITERATURE CITED

1. PICKERING, W. The chemistry of Bordeaux mixture. Jour. Chem. Soc. London, Vol. XCI, 1907, pp. 1988 and 2001.
2. FIELDS, W. S., and ELLIOTT, J. A. Making Bordeaux mixture and some other spraying problems. Ark. Agr. Exp. Sta. Bul. 172 (1920), 12 p.
3. COOK, F. E. and MCINDOO, N. E. Chemical, Physical and Insecticidal Properties of Arsenicals. U. S. Dept. Agr. Bul. 1147 (1923), 57 p.
4. GOODWIN, W., and MARTIN, H. Bordeaux mixture combined with arsenical sprays. *In* Jour. Agr. Science (1928), Vol. 18, part 3, pp. 460–477.
5. SANDERS, G. E., and KELSALL, A. Some miscellaneous observations on the origin and present use of some insecticides and fungicides. *In* Proc. Ent. Soc. Nova Scotia for 1918, No. 4, pp. 69–73.
6. SANDERS, G. E., and BRITTAIN, W. H. The toxic value of some poisons alone and in combination with fungicides, on a few species of biting insects. *In* Proc. Ent. Soc. Nova Scotia for 1916, No. 2, pp. 55–64.

RESULTS OF SPRAYING AND DUSTING EXPERIMENTS ON LARGE BLOCKS OF PEACH TREES FOR THE CONTROL OF THE CURCULIO

By OLIVER I. SNAPP, *Entomologist in Charge, U. S. Peach Insect Laboratory, Fort Valley, Georgia*

ABSTRACT

Blocks of peach trees 26 by 26 rows each were used for these experiments to determine the comparative effectiveness of spraying and dusting and to test the value of the "petal-fall" application. Lead arsenate applied as a spray was found to be more effective against the curculio (*Conotrachelus nenuphar* Herbst) attacking peaches than the same insecticide applied in a dust mixture. The petal-fall spray, applied when 50 to 75 per cent of the petals had fallen, was shown to be an important part of the spray schedule.

For more than ten years the writer has been investigating the comparative effectiveness of lead arsenate in sprays and in dust mixtures for the control of the curculio, *Conotrachelus nenuphar* Herbst, attacking peaches. The experiments were usually conducted on plats of approximately 200 trees each, and under conditions of moderate curculio infestations there appeared to be little difference in the control from the insecticide applied by the two methods. Therefore, the Bureau has been issuing both a spraying schedule and a dusting schedule for the control of the curculio on peach trees, leaving it to the grower to choose the method of applying the insecticide.

During years when a very heavy curculio infestation occurred, our results showed that the lead arsenate applied as a spray gave better control of the curculio than the same insecticide in a dust mixture. On account of the heavy curculio population going into hibernation last fall as a result of the leaving of a considerable quantity of wormy peaches in the orchards when the peach markets collapsed during the season of 1928, and owing to the following mild winter, we predicted an unusually heavy curculio infestation in 1929. Throughout the entire Southern peach-growing region it proved to be perhaps the heaviest infestation on record, and the second heaviest ever to have occurred in the Georgia peach belt. That prediction caused us to decide to test durin season of 1929, the comparative effectiveness of the two methods of applying lead arsenate, on blocks of peach trees much larger than we had ever used before. Since the effectiveness of the "petal-fall" application for curculio control is still not fully appreciated, we decided to test also the value of that application on a large block of trees.

Orchard Used for Experiments in 1929. A six-year-old Elberta orchard near Fort Valley, in the heart of the Georgia peach belt, was used for the experiments. It contained the heaviest curculio infestation of any orchard in the district with which we were familiar. As a result of the lack of control measures, a heavy curculio population was built up in this orchard by the season of 1928. The orchard bore a heavy crop that year, but on account of the wormy and rotten condition of the fruit and the collapse of the peach market, none of the fruit was picked. It was allowed to fall to the ground, and it was not afterwards removed from under the trees. Jarring trees in this orchard when the curculio beetles began leaving hibernation in the spring of 1929, to ascertain the extent of the infestation, showed as high as 25 curculios per tree. The experiments were therefore conducted in an orchard in which the curculio infestation was perhaps as heavy as it ever occurs.

SCHEDULES TESTED AND HISTORY OF APPLICATIONS. The orchard contained 1,797 vigorous trees in a good state of productivity. It was bordered on three sides by cultivated fields and on the fourth side by an orchard. The blocks were headed into this adjoining orchard so that no block was subjected to more sources of curculio infestation than another. There were no wooded areas or uncultivated fields near by to subject any part of the orchard to such favored places of hibernation. It was an ideal place to test the effectiveness of several schedules of arsenical treatments.

The orchard was divided into three blocks of 26 by 26 rows each. Block one contained 608 trees, block two contained 626 trees, and block three contained 563 trees. The following outline gives the schedules that were tested on these blocks.

OUTLINE OF EXPERIMENTS IN SPRAYING AND DUSTING PEACH TREES, FOR THE SEASON OF 1929, FORT VALLEY, GA.

Block No.	Treated with	Time of Application			
		As petals fall	When calyces are shedding	Two weeks after shedding of calyces	Four weeks before harvest
I.....	Dust	0–5–95	0–5–95	80–5–15	80–5–15
II.....	Spray	A.L.L.	A.L.L.	A.L.L. + fungicide	A.L.L. + fungicide
III.....	Spray	———	A.L.L.	A.L.L. + fungicide	A.L.L. + fungicide

0–5–95 = Lead Arsenate, 5 per cent; hydrated lime, 95 per cent.
80–5–15 = Sulphur, 80 per cent; lead arsenate, 5 per cent; hydrated lime, 15 per cent.
A.L. = Lead arsenate powder, 1 pound to 50 gallons of spray.
L. = Milk of lime, made from 4 pounds of hydrated lime per 50 gallons of spray.

Each application was given to the three blocks on the same day. The dusting was done about sun-up in the morning, which is usually the calmest time of the day, and most of the spray was applied when the wind was very light. H. S. Swingle supervised all the dusting and spraying, and placed the ingredients in the machines. He saw to it that each tree received a thorough application of spray or dust at each time of treatment, and is due credit for assisting with these experiments until the beginning of harvest. The dusts were applied with a dusting machine driven by a 3½ H. P. engine and the sprays were applied at a pressure of 250 pounds with a sprayer driven by a 3 H. P. engine.

At the first application Block No. I received 160 pounds of dust in one hour and twenty minutes, and Block No. II received 300 gallons of spray in two hours and one minute. At the second application, Block No. I received 170 pounds of dust in one hour and twenty minutes, Block No. II received 475 gallons of spray in three hours and forty

minutes, and Block No. III received 400 gallons of spray in two hours and fifty-five minutes. At the third application Block I received 300 pounds of dust in one hour and thirty minutes, Block II received 570 gallons of spray in four hours and five minutes, and Block III received 450 gallons of spray in three hours and twenty-five minutes. At the fourth application Block I received 285 pounds of dust in one hour and ten minutes, Block II received 408 gallons of spray in two hours and forty-five minutes, and Block III received 352 gallons of spray in two hours and twenty minutes.

RESULTS. Ten trees were selected in the center of each block as record trees. As there were 26 rows between the record trees of each block, there was no danger of a drift of spray or dust from an adjoining block to the record trees. All of the drops that fell from the record trees were collected and cut open to determine the percentage infested by the curculio, as the adults that develop from infested drops deposit the eggs for the second brood of larvae which appear in the peaches at harvest. At harvest all of the fruit was taken from the record trees and cut open to ascertain the exact percentage of the matured fruit damaged by the curculio.

Table 1 gives the results obtained from the examination of drops from the record trees in each block.

TABLE 1. NUMBER OF PEACH DROPS, AND PERCENTAGE OF THEM INFESTED BY CURCULIO; SPRAYING AND DUSTING EXPERIMENTS, FORT VALLEY, GA., 1929

Block	Treatment	Total number of drops examined	Total percentage of drops infested by the curculio
I. . .	Dust, full schedule	8,844	39.6
II. . .	Liquid spray, full schedule	9,514	28.6
III. . .	Liquid spray, petal-fall application omitted	8,940	39.4

There was 38.5 per cent more wormy drops in the dusted block than in the sprayed block. In the block where the first spray was omitted there was 37.8 per cent more wormy drops than in the sprayed block that received the early spray for the curculio. A reduction of the amount of curculio infestation in the drops correspondingly reduces the size of the second brood of larvae at harvest.

Table 2 presents the results obtained from the examination of the fruit from the record trees of each block at harvest time.

The dusted block had 30.2 per cent more wormy fruit than the sprayed block. The sprayed block on which the first application was omitted had 30.0 per cent more wormy fruit than the sprayed block on which the usual four applications were used. The results on brown rot were taken to show the interrelation between curculio injury and brown rot in-

TABLE 2. SUMMARY OF RESULTS OF EXAMINATION OF PEACHES AT HARVEST; SPRAYING AND DUSTING EXPERIMENTS, FORT VALLEY, GA., 1929

Block	Treatment	Total No. fruit	Percentage of total fruit having— Curculio larvae	Brown rot	Curculio larvae only	Brown rot only	Curculio larvae and brown rot	Brown rot infection at curculio puncture	Percentage of total fruit found to be sound
I	Dust, full schedule.....	1,017	56.0	33.3	36.8	14.1	7.9	11.3	30.0
II	Liquid spray, full schedule.....	1,799	43.0	11.7	38.9	7.6	0.7	3.4	49.4
III	Liquid spray, petal-fall application omitted..	1,404	55.9	22.4	43.7	10.2	4.1	8.1	33.9

fection. The dusted block had 184.6 per cent more rotten fruit than the block that received the spray. The infection on 11.3 per cent of the rotten fruit was at curculio punctures. While the two sprayed blocks were given the same fungicidal treatments, there was 91.5 per cent more rotten fruit in Block III where the first curculio spray was omitted than in Block II that received the early spray. 8.1 per cent of the brown rot infections in Block III were at curculio punctures. Of the rotten fruit in the block that received four applications of spray, only 3.4 per cent was at curculio punctures.

The percentage of total fruit found to be sound is not high; however, in interpreting the results of these experiments, one must first consider the conditions that existed in this orchard when the work was started and the very severe test to which all treatments were put. The Elberta peaches from this orchard were better than those produced in any of the other orchards of that locality.

Conclusions

1. Lead arsenate applied as a spray is more effective against the curculio attacking peaches than the same insecticide applied in a dust mixture.

2. The petal-fall spray, applied when 50 to 75 per cent of the petals have fallen, has been shown to be an important part of the spray schedule.

THE ONION THRIPS ON SEEDLING COTTON, WITH A SEASON'S RECORD OF PARTHENOGENETIC DEVELOPMENT*

By C. O. Eddy and W. H. Clarke,[1] *S. C. Experiment Station*

Abstract

Infestations of the onion thrips, *Thrips tabaci* Lind., caused seedling cotton plants to grow slowly and assume a malformed condition. Buds were rarely blasted. Lateral growth sometimes resulted. Unfolding leaves had holes, marginal erosions, raised thin areas, and a crinkly surface. Using approximate figures, the average unmated female lived 14 days and laid 14 eggs in a period of eight days. Individuals developed in 14 days, nearly five days being spent in the egg, between two and three in each of the two larval instars, one and one-half in the propupa, and three in the pupa. In July a generation followed the previous one as closely as 15 days, the period lengthening to 26 days in August.

*Technical Contribution No. 1 (New Series) from the South Carolina Agricultural Experiment Station.

[1]Resigned January 15, 1930. Now with Georgia State Board of Entomology.

During the last several years when seedling cotton plants were growing slowly and abnormally in South Carolina, several species of thrips have been present in the unfolding buds and on the leaves. This fact has also been observed by other workers in Louisiana, Texas, Georgia, and perhaps in other states, as shown in the cooperative reports of cotton insect activity issued from the Delta Laboratory of the United States Bureau of Entomology at Tallulah, Louisiana. One of the most abundant species of thrips in South Carolina has been the onion thrips, *Thrips tabaci* Lind.[2]

OBJECT. In insectary tests during 1929 experiments were conducted to determine the type of injury onion thrips caused to seedling cotton plants. In further studies data were collected on the life history of the insect during five generations of parthenogenetic development from May 26 to September 25 of that season.

INJURY. A successful method used in determining the type of injury caused by the onion thrips involved the use of soil tables in which seedling plants were grown. Infestations of the thrips on the seedling plants were roughly controlled. Different degrees of infestations were established in various series of tests, the number of insects per plant varying from one to ten.

Plate 23 shows two seedling plants which had been attacked by the onion thrips compared with one which was uninfested by the insect. It may be seen from a study of the illustrations that growth proceeded terminally but more slowly and in a very much malformed condition. Buds were rarely blasted. It may also be noted that lateral growth was started from the buds in the axils of the cotyledon leaves in certain cases. This condition occurred more commonly in plants which were infested with thrips than in normal plants, but much less frequently than in plants attacked by the cotton flea hopper, *Psallus seriatus* Reut. Almost no growth was apparent on certain infested plants. Plants in that condition were frequently retarded as much as two weeks or more.

A close observation of leaves that have unfolded from infested buds shows holes, marginal erosions, raised thin areas, and a crinkly surface. The degree of injury of this kind increases with greater infestations.

A discussion of the removal of tissue from the lower surface of unfolded leaves is omitted as this factor seems to have very much less effect on seedling cotton growth than does the destruction of tissues in the buds.

[2]Determinations by Professor J. R. Watson of the Florida Experiment Station and by Mr. A. C. Morgan of the Bureau of Entomology.

TABLE 1. RECORD OF UNMATED FEMALES—1929

Gen.	No. of cases	Pre-oviposition period Max.	Min.	Av.	Oviposition period Max.	Min.	Av.	Post-oviposition period Max.	Min.	Av.	Total life of female Max.	Min.	Av.	Eggs per female per gen.	Max. eggs by one female	Min. eggs by one female	Eggs per day by one female Max.	Min.	Av.	Period during which females lived	
1	5	7	2	5.4	14	1	5.8	6	1	2.6	22	5	13.0	10.8	28	1	10	0	1.86	6/10	7/2
2	5	4	2	3.0	14	3	8.0	4	0	1.6	18	8	12.6	22.8	46	5	14	0	2.85	6/29	7/19
3	10	6	2	3.6	24	1	11.9	5	0	2.4	28	7	16.9	20.2	46	3	8	0	1.42	7/15	8/28
4	13	6	1	3.69	26	1	7.77	6	1	3.38	28	4	14.62	11.16	33	1	6	0	1.44	7/31	9/20
5	4	5	3	3.75	12	1	7.00	4	2	2.75	17	9	12.5	5.5	8	2	4	0	0.79	8/23	9/25
All Gen.	37	7	1	3.81	26	1	8.57	6	0	2.7	28	4	14.51	14.51	46	1	14	0	1.69		

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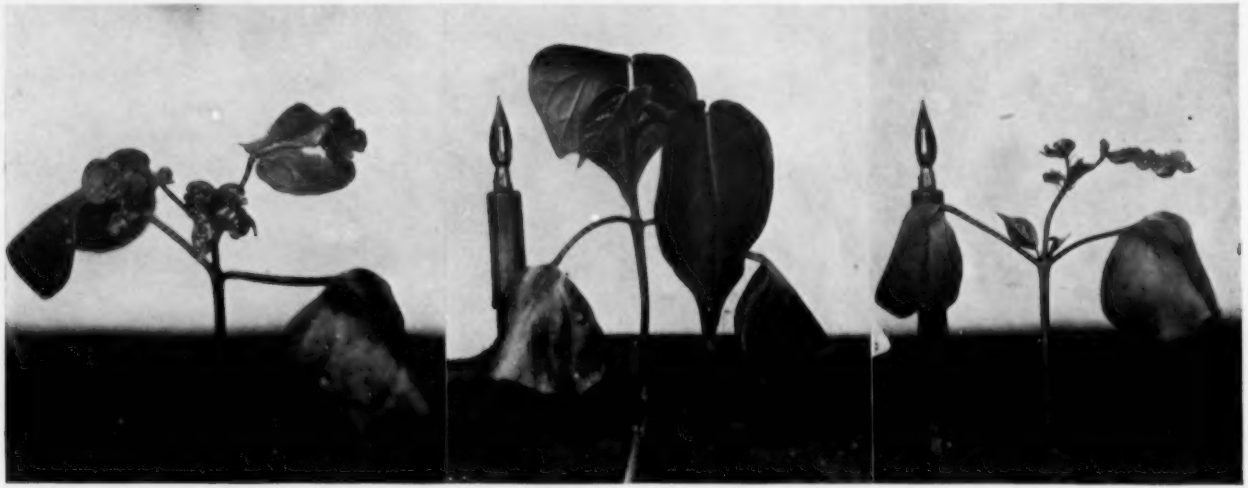


Two cotton seedling plants injured by the onion thrips. Check in the center.

TABLE 2. SUMMARY OF DEVELOPMENT BY GENERATIONS MAY 26 TO AUGUST 23

Gen.	Cases	Date first eggs	Incubation period	First instar	Second instar	Propupa	Pupa	Date last adult emerges	Larval and pupal dev.	Incubation and dev.	Av. mean temp.
1	9	5/26	5.2	3.0	2.6	1.3	3.2	6/28	10.2	15.3	75
2	15	6/16	4.5	2.7	2.5	1.7	2.6	7/15	9.6	14.2	79
3	47	7/3	4.7	2.4	2.7	1.4	2.9	8/2	9.4	14.1	78
4	51	7/18	4.5	2.4	2.8	1.2	2.7	9/9	9.2	13.7	77
5	48	8/9	4.4	2.2	3.2	1.3	3.2	Closed 9/24	9.9	14.4	76
6	2	8/31	5.0	1.5	3.5	1.5	4.5	Closed 9/23	11.0	16.0	74
All Gen.	172	5/26	4.72	2.33	2.88	1.4	3.18	Closed 9/24	9.88	14.62	76.5

PARTHENOGENETIC LIFE HISTORY. The life history studies with the onion thrips were carried on by the use of one-gram homeopathic vials, ¾ by 6 inch test tubes, absorbent cotton, insect-free seedling cotton leaves, and water. The virgin females were confined separately in the homeopathic vials and a section of a fresh seedling cotton leaf placed with each of them every 24 hours. The used sections of leaves were removed from the vials, wrapped individually in moist absorbent cotton, and each placed in a sterile test tube. The open ends of both vials and test tubes were closed with absorbent cotton plugs. The leaves in the test tubes were removed daily and observed under a low power binocular microscope for emerged larvae. When a larva was found, it was removed from the leaf with a small brush and transferred to a fresh leaf in a small homeopathic vial where development was observed. Fresh leaves were supplied to all larvae when needed. Vials and test tubes containing the thrips were inserted slightly in the soil of soil tables in an outdoor insectary.

TABLE 3. SUCCESSION OF GENERATIONS STUDIED

Gen.	First eggs laid	Last adult died	Total days
X	—	6/29	—
1	—	7/2	—
2	6/11	7/19	38
Interval of 22 days			
3	7/3	8/28	56
Interval of 15 days			
4	7/18	9/20	64
Interval of 16 days			
5	8/3	9/25	—
Interval of 26 days			
6	8/29	9/25	—

ACTIVITY OF FEMALES. Adult female onion thrips were collected in the field over a period of about two weeks during early May 1929.

These individuals were placed on test as described above. Records reported do not include the activities of these females, but begin with the incubation of the eggs produced by them, these later forms constituting what we have designated as the first generation.

The following data are based on the records secured from 37 virgin females representing five generations between June 12 and September 25. The data are shown in summary form in Table 1. As the eggs were deposited in the plant tissue, the number laid could not be easily nor accurately determined. A record of the number of larvae emerging from the leaf tissue is substituted for the number of eggs laid.

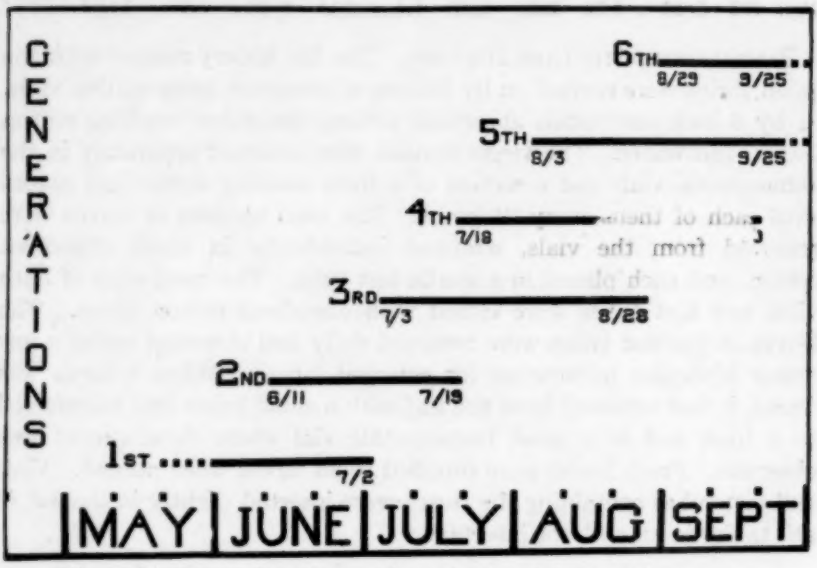


Figure 60.—Succession of generations of onion thrips reared on cotton.

DEVELOPMENT. The data of development are presented under the form closely approximating that of complete metamorphosis: i. e., egg, larva, pupa, and adult, there being with the Thysanoptera two feeding larval instars and a non-feeding propupal and a pupal stage. The data is presented in Table 2 without discussion.

A study of the succession of generations is presented in Table 3 and graphically illustrated in Figure 60. It is interesting to note that generations followed as closely as 15 days in July, the period lengthening to 26 days in August.

ERAX INTERRUPTUS MACQ. AS A PREDATOR

By B. A. OSTERBERGER, *Louisiana Experiment Station*[1]

ABSTRACT

During the fall and winter of 1928 and 1929 there were found in the soil in fields of sugarcane and other field crops many larvae of *Erax interruptus*. Laboratory experiments indicate that the larvae feed very readily on white grubs. Pupation began the first week in May and lasted until the first week in June, requiring from 20 to 26 days for the transformation to adult. *Erax interruptus* is of economic importance in sugarcane areas as a predator attacking white grubs of *Euetheola rugiceps*, the sugarcane beetle.

Examinations of freshly plowed soil during the fall and winter of 1928 yielded many slender, creamy white larvae, legless and with body tapering towards each end. These larvae when full grown were from 25 to 30 mm in length, and had tiny brown heads partly covered by the thorax, and with prominent mandibles. Some of these larvae were sent to Dr. C. P. Alexander and Mr. Stanley W. Bromley. The species was not definitely fixed as *Erax interruptus* Macquart until adults were bred.

In these observations were also found many white grubs; so working on the assumption that these were the natural food of the species, fourteen of the larvae were placed in sterilized salve boxes with sterilized soil, and in each box was placed a white grub. Daily observations were made and fresh white grubs were added as needed until the adults emerged. Considerable difficulty was experienced from molds and mites introduced with fresh white grubs. Several larvae were killed. This difficulty was finally overcome by frequent change of sterilized boxes and soil and by dipping the white grubs in a very weak formaldehyde solution and by washing in water.

TABLE 1. LIFE HISTORY AND FEEDING ACTIVITIES OF *Erax interruptus*

Larvae No.	Date Collected	Grubs Consumed	Larvae Died	Larvae Pupated	Adult Emerged
1.....	Dec. 1, '28	1	Apr. 12, '29		
2.....	" " "	2		May 17, '29	June 6, '29
3.....	" " "	2	Feb. 5, '29		
4.....	" " "	1	May 17, '29		
5.....	" " "	0	Mar. 22, '29		
6.....	" " "	2		May 13, '29	June 3, '29
7.....	" " "	1	Feb. 1, '29		
8.....	" " "	1	Jan. 19, '29		
9.....	" " "	0	Jan. 11, '29		
10.....	" " "	1	Mar. 5, '29		
11.....	" " "	1		May 8, '29	June 3, '29
12.....	" " "	1	Apr. 1, '29		
13.....	" " "	0	Apr. 1, '29		
14.....	" " "	0		May 20, '29	June 10, '29

[1]Published by permission of the Director, Louisiana Experiment Station.

The feeding (Pl. 24, fig. 1) was accomplished by the larva attaching itself to the white grub in a tender, unprotected region just back of the head. There it remained attached until all the body fluids were sapped, leaving the white grub very limp. Daily records were kept of the number of white grubs used in feeding the *Erax* larvae:

Erax interruptus hibernates in the soil in the larval stage. Under laboratory conditions pupation was begun after the first week in May, and adults emerged the first week in June. The length of pupal stage varied from 20 to 26 days.

The pupa (Pl. 24, fig. 1) was yellowish brown, from 15 to 20 mm in length, heavily armed with spines and with prominent spiracles on most of the abdominal segments. Many empty pupal cases have been found after rains, especially in the more sandy river soils.

The adult (Pl. 24, figs. 3, 4) has a pair of large eyes, and the head is mounted on a narrow neck which enables the insect to see in all directions. The proboscis is long, sharp and stiffened by a heavy coat of chitin. The body is from 20 to 25 mm in length, slender, but with strong long legs. The wings are sufficiently strong to enable swift flight and also the carrying of its prey, which may be larger than the fly itself. The abdomen has traces of short gray hair, and the head and legs are covered with long gray hairs.

In view of the feeding habits of the larva and its wide distribution and abundance, *Erax interruptus* is one of the most beneficial Asilidae. Its value as a predator in the adult stage is recognized, but little has been known about its food habits in the larval stage.

Titus in 1905 listed a species of *Erax* as a predator of the white grub of the sugarcane beetle (*Euetheola rugiceps*). It is hoped that future work will point out a way to make *Erax* more effective as a natural check on the activities of this and other similar crop pests.

The writer wishes to express thanks to Dr. C. P. Alexander for his interest and suggestions and to Mr. Stanley W. Bromley for determining specimens, and for information on habits and distribution.

Literature

Aldrich, J. M. A Catalogue of North American Diptera. pp. 275–278. Smithsonian Institute, Washington, D. C. 1905.

Bromley, S. W. The Asilidae of Cuba (Diptera). Annals, Entomological Society of America. Vol. 22, No. 2, pp. 272–297. Illust. 1929.

Comstock, J. H. An Introduction to Entomology. pp. 840–841. Illust. Comstock Publishing Co., Ithaca, N. Y. 1925.

Davis, J. J. Common White Grubs. Farmers' Bulletin No. 940—30p. Illust. 1922.

Erax interruptus Macq.; 1—Mature larva feeding on white grub, slightly enlarged; 2—Pupa, slightly reduced; 3—Adult female, slightly reduced; 4—Adult male, slightly reduced.

TITUS, E. S. G. Some Miscellaneous Results of the Work of the Bureau of Entomology. U. S. Bureau of Entomology Bulletin No. 54. pp. 15–16. Illust. 1905.
WELLHOUSE, W. H. How Insects Live. An Elementary Entomology. pp. 229–233. Illust. Macmillan Company, New York City. 1926.

THE OCCURRENCE OF *ANTICARSIA GEMMATILIS* AS A SOYBEAN PEST IN LOUISIANA IN 1929

By W. E. HINDS, *Entomologist Louisiana Experiment Station*

ABSTRACT

This tropical species appeared in injurious numbers for the first time in Louisiana in August 1929. It showed a decided preference for soybean varieties rather than velvet beans. The infestation resulting in defoliation of soybeans appeared earliest in the vicinity of Jeanerette, Louisiana and gradually spread northward to the middle of the State. Brief notes on life history, habits and natural enemies were secured. Late in August a general development of a fungus disease believed to be *Empusa rileyi*, checked the further multiplication of the species in an important degree. Insecticidal control was found possible with calcium arsenate containing 5% of hydrated lime and dusted on the dry foliage. Arsenate of lead was not advisable. Sodium silicofluoride of the light dust type, without hydrated lime, gave good control of the worms with very little foliage burning where applied to dry foliage. Poisoned plants put out new growth while unpoisoned plants were completely destroyed and seed setting prevented by the worms.

This tropical species has been known for many years in Florida as a frequent pest defoliating velvet beans. Its occurrence there is reported as being sporadic and its injuriousness seems to depend in considerable degree upon the earliness of its arrival each season. According to Professor J. R. Watson of the Florida Experiment Station, the culture of soybeans was rare in Florida and this caterpillar was not observed attacking soybeans in that State until 1926.

While it is quite certain that the species has occurred in Louisiana in limited numbers before the season of 1929, there is no record to indicate that it has ever occurred in any considerable abundance before that season. On August 14, 1929, as the writer was visiting Professor W. R. Dodson, Superintendent of the U. S. Livestock Experiment Station at Jeanerette, Louisiana, Professor Dodson called attention to the abundance of some species of caterpillar which was defoliating soybeans generally in that section. At that time, in the most advanced cases of injury, the tops of the plants showed the condition which is known as "ragging" in cotton where the cotton leaf worm is in process of stripping that plant. Professor Dodson was largely responsible for the introduction and widespread culture of the soybean in Louisiana and has

been interested for many years in improving varieties of soybeans for use in this State. Some of this variety testing and improvement work was under way at Jeanerette. It was very evident that this new pest on soybeans found certain varieties more susceptible to its attack or more attractive to its taste than were other varieties. Varieties like Otootan and Laredo were stripped much more quickly and completely than varieties like Biloxi which were taller and more open in growth.

The first evidence of stripping was noted by Professor Dodson at Jeanerette during the first week of August and in 10 days time some varieties were as completely defoliated as cotton is following an outbreak of the cotton leaf worm. The worms showed many points of resemblance to the cotton species. They are of practically the same size when full grown and also have the habit of dropping quickly to the ground upon the jarring of the plant on which they are feeding. Some of these resemblances, as well as differences in appearance, may be seen by reference to the illustrations given herewith.

A brief series of observations upon the life history and habits of Anticarsia indicated that the eggs are laid singly and scattered about the plant, especially on the leaf stems and mid-ribs where the pilosity is heaviest. Observation of the act of oviposition indicated that this occurs at about dusk, and is probably continued into the night. In the case observed the females seem to depend upon finding a surface that was quite rough to assist in scraping the egg from the tip of the abdomen as it was deposited. It appears that the developmental periods for eggs, larvae and pupae are very similar to those occurring for the cotton leaf worm and that a new generation may occur at intervals of about 5 weeks.

Pupation in the case of Anticarsia does not occur by webbing up on the plant as is the case with *Alabama argillacea*. When full grown the Anticarsia larvae go to the ground and pupate at or slightly below the surface of the ground, under trash, or buried in the surface soil. Most of the pupae found were not more than 1 inch deep in the soil.

It appears that the adult moths feed on nectar as they occurred in abundance at rows of Crotalaria which were growing near the soybeans but there was no indication of the feeding of Anticarsia larvae on this Crotalaria.

So far as food plants of Anticarsia are concerned, all species or varieties of soybeans were attacked but only very limited feeding occurred on velvet beans growing in adjacent rows at the Louisiana Experiment Station. The only wild food plant observed was the "black locust" (*Robinia pseudoacacia* L.). Tender sprout growth of this species was

stripped completely by Anticarsia larvae but no general stripping of locust foliage occurred.

The advance of Anticarsia from the southern portion of Louisiana, where the earliest stripping occurred, extended northward to the middle of the State. Stripping was common but not complete at Baton Rouge and decreased steadily further north. The peak of the infestation occurred at Jeanerette at about August 20 and at Baton Rouge about 10 days later.

During the height of the infestation a number of natural enemies of Anticarsia were noted attacking it. The English sparrow came by flocks to the infested soybean fields and fed extensively upon the larvae. They were observed to light particularly in the tall erect stiff-growing Biloxi plats. The birds followed the worms to the ground and numbers were seen with worms in their mouths.

Carabidae larvae, of several species, were gorging themselves upon the Anticarsia larvae on the ground. Several species of Vespoid-wasps were abundant in the infested fields and some of them were observed in the act of feeding upon the Anticarsia larvae. Dipterous parasites did not seem to be at all abundant at this time.

Undoubtedly the most effective natural enemy appearing in Louisiana was a fungus disease which destroyed the larvae. This disease appeared as a pure white coating on the bodies of the dead larvae which usually remained attached to the plant near where they had fed last. This disease is believed to be *Empusa rileyi* and has been reported as being very effective in Florida in controlling the fall development of Anticarsia. This disease appeared at Baton Rouge during the last week of August and increased rapidly in its destruction of larvae during the next two or three weeks. It is quite possible that this disease may have been an important factor in preventing further damage by Anticarsia in the fall of 1929.

Insecticidal control measures were tested hurriedly and but partially. The foliage of soybeans is well known to be very susceptible to burning by arsenical applications. However, applications of calcium arsenate mixed with 5% hydrated lime did not burn the foliage seriously and seemed to give fairly satisfactory control of the worms. Low growing soybeans are very difficult to treat effectively with a dust application. The best treatment that could be given was by means of saddle guns, dusting 2 rows at a time. Applications of Jungmann's Extra Light Sodium silicofluoride without hydrated lime gave very fair control of the worms with very little burning of foliage. It appeared that the best time for application of either material was in the late afternoon, usually from about 5:00 P. M. until dark.

Arsenical dusts were applied at the Louisiana Experiment Station too late in the season to secure very satisfactory evidence as to their value in general field applications. However at Jeanerette, Professor Dodson used calcium arsenate extensively, earlier in the season and reported that the treatment checked the worms quite promptly but with some burning of foliage. However, the treated areas were so well protected from further worm attack that the buds in the leaf axils were preserved. Therefore the treated areas put out new foliage promptly and continued a growth which assisted in the maturing of seed in valuable seed plats, while in untreated areas the worms destroyed the buds so thoroughly that no further growth occurred and the seed crop was largely destroyed. It appears, therefore, that arsenical applications, or sodium silicofluoride dust, should be used for the control of *Anticarsia gemmatilis* where the maturity of the seed is desired.

However, if the soybean crop is being grown primarily for forage, or as a green manuring crop, it would seem to be advisable to harvest as soon as the threat of defoliation becomes general, or to plow under the crop at that time.

It is encouraging for soybean growers to know that this species is, apparently, of tropical origin and cannot survive an ordinary winter in Louisiana. All stages except the pupae are destroyed immediately by killing frost and any adults emerging after the first frost would be destroyed, together with their offsprings, if a second frost should occur some 8 or 10 weeks after the first. It is not likely, therefore, that this species will ever be found a regularly occurring, or generally serious pest of soybeans in Louisiana.

Explanation of Plates

Plate 25. *Anticarsia gemmatilis* Hubn.

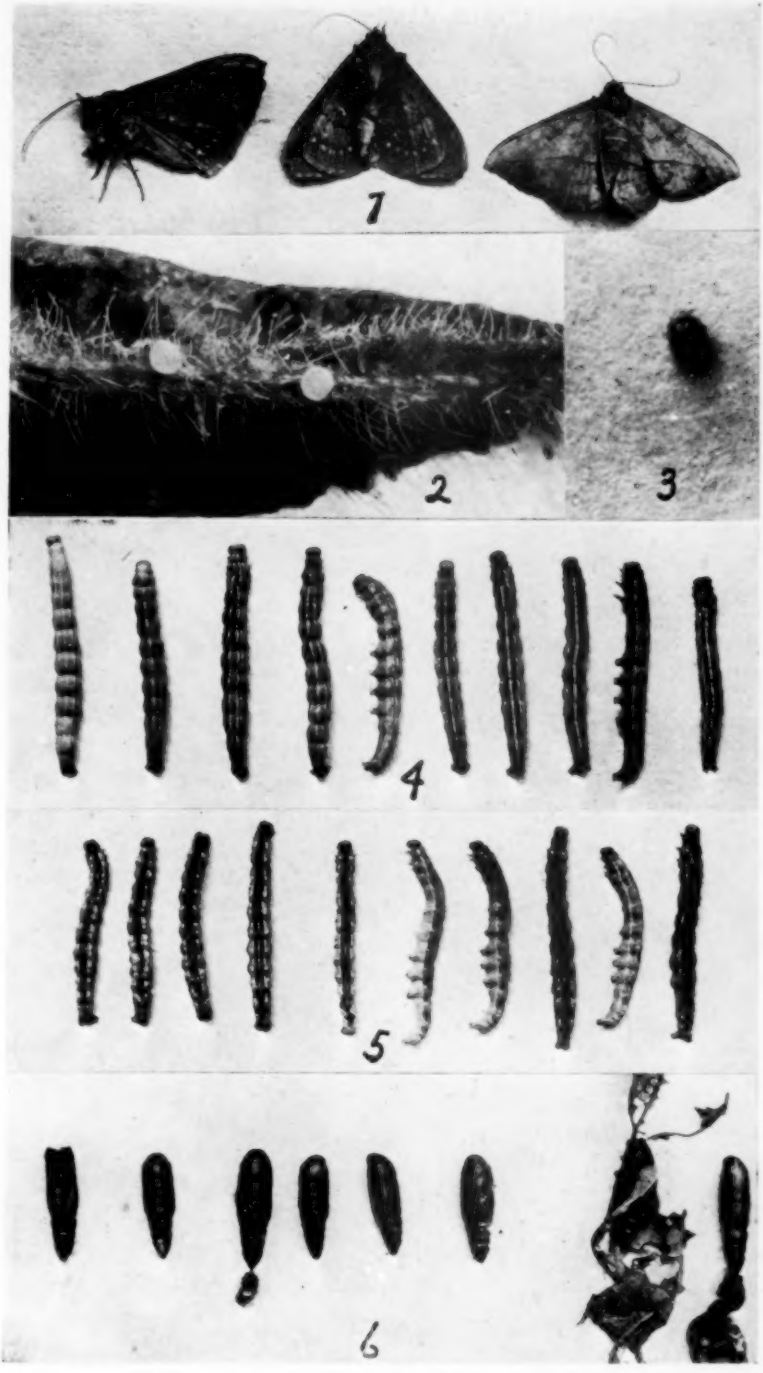
Fig. 1.—Adults, side, ventral and dorsal aspects; Fig. 2.—Fresh eggs, bluish green, on mid-rib, times 8/1; Fig. 3.—Egg ready to hatch, orange colored; Fig. 4.—Anticarsia larvae showing variations in size and color markings from olive green on left to nearly black at right; Fig. 5.—*Alabama argillacea* larvae for comparison with Fig. 4; Fig. 6.—Anticarsia pupae at left compared with two *Alabama argillacea* pupae at right. All photos original, X ¾ except Figs. 2 and 3.

Plate 26. *Anticarsia gemmatilis* on Soybeans

Fig. 7.—Head capsules of Anticarsia larvae, X 8/1; Fig. 8.—Head capsules of *Alabama argillacea* for comparison with Fig. 7, X 8/1; Fig. 9.—Close view of soybeans nearly defoliated; Fig. 10.—General condition in same area as Fig. 9 after leaf tissue was devoured. All photos original.

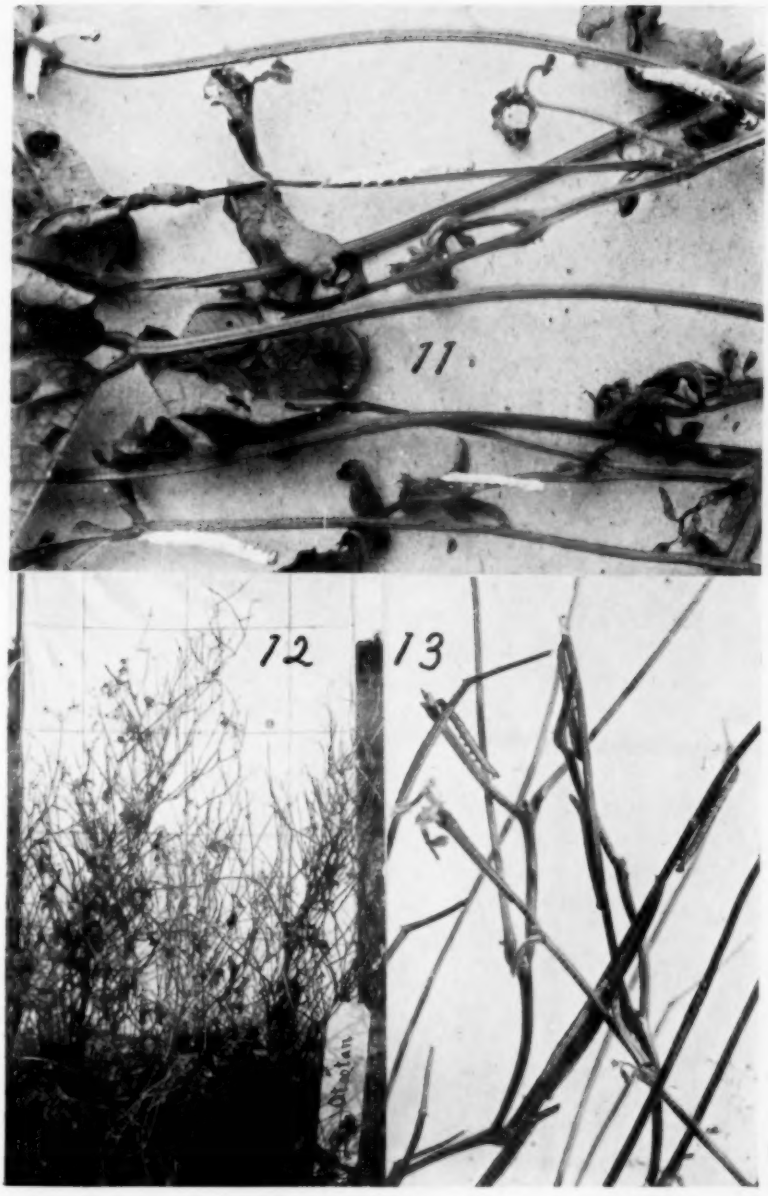
Plate 27. *Anticarsia gemmatilis* on Soybeans

Fig. 11.—Fungus disease (*Empusa rileyi?*) destroying larvae of Anticarsia—specimens as found in the field; Fig. 12.—Ototan beans after defoliation; Fig. 13.—Close view in tops of plants shown in Fig. 12. All photos original.

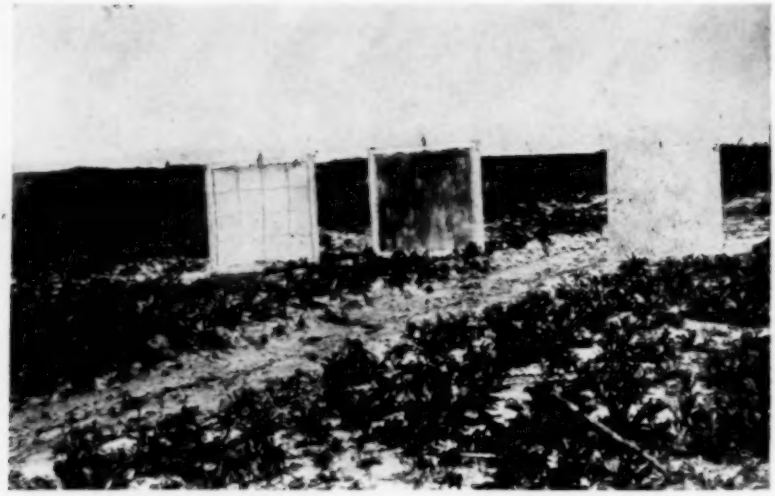


Anticarsia gemmatilis Hubn.

Anticarsia gemmatilis on Soybeans



Anticarsia gemmatilis on Soybeans



1.—Cheesecloth, voile syrup treated, and plain voile screens, (left to right) being tested for efficiency in catching wind drifted forms of plant lice.

2.—Hardware cloth screen mounted on pivot and turning with the wind. Coated with Tanglefoot. The screen can be taken out of the slot and new ones inserted at what ever intervals are desired.

SOME METHODS OF TRAPPING PLANT LICE

By FRANK M. HULL, *Plant Lice Laboratory, Texas Agricultural Experiment Station*

ABSTRACT

Screens constructed of cheese cloth and voile were tested in comparison to screens made of hardware cloth and coated with tanglefoot. The latter type when developed on the style of a movable wind vane proved the most satisfactory. Eight mesh wire cloth was used and the Tanglefoot thinned by heating before being applied to the screens. The records seem to show that there are two periods of the year more dangerous than others to the crop so far as infestation with lice is concerned. Crops planted at periods when there is little wind movement of lice have an advantage over others.

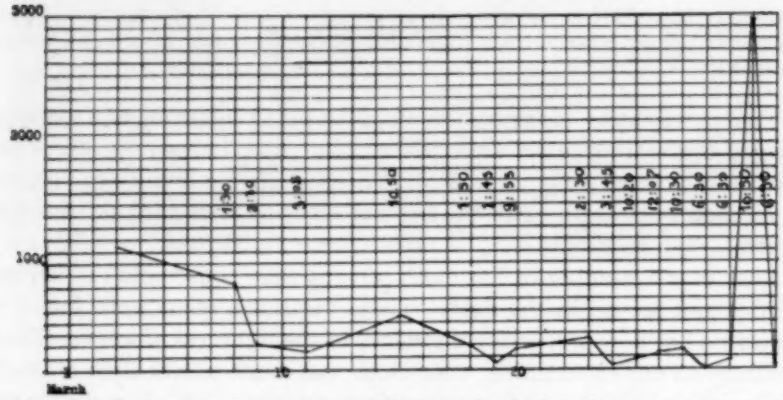
The possibilities along the line of trapping plant lice, especially winged forms, were early seen at the Plant Lice Laboratory and were especially pointed out by Dr. F. L. Thomas. Accordingly experiments in method were begun with the hope of securing data with reference to control.

Last year a number of flat cloth screens were constructed of several fabrics and set up in the field. These vertical screens were found to register a lice flow proportional roughly to the tightness of weave. Thus, contrary to our expectation, voile cloth was much poorer than ordinary cheese cloth. Cheese cloth was the first material tried. It is flimsy and does not last well. It appears to be approximately fifty per cent more efficient, so far as concerns the number of lice caught. In the more solidly woven materials, the air, instead of passing through the screen, veers about and around it. This is to be expected but it carries the lice with it. We tried improving the efficiency of the cloth by coating with molasses syrup and tanglefoot. Neither the tanglefoot nor the syrup can be applied without serving to further close the pores of the fabric and the syrup is washed away with every heavy dew. These screens are shown in Pl. 28, fig. 1.

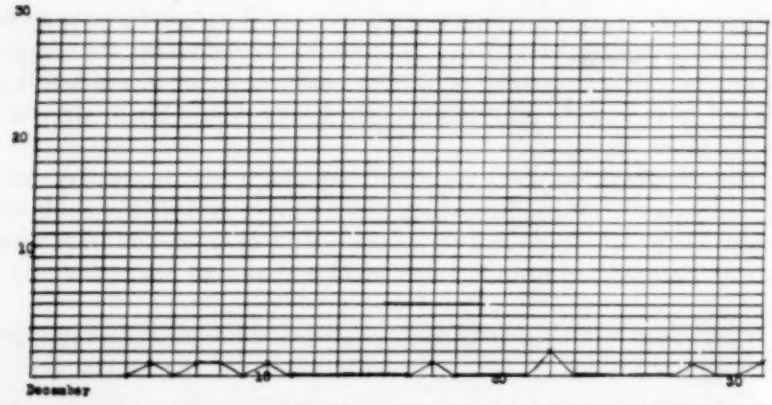
The drawback to cloth untreated screens is the temporary nature of the register. Those lice which come to rest against the cloth crawl away, are blown off, or fall off in the course of time, and such screens cannot be used for periods much greater than one hour with any accuracy.

Tanglefoot was tried first upon ordinary screen wire. It cannot be successfully applied to such wire even when thinned by heating since the meshes are filled up with the sticky substance. We found that if we thinned tanglefoot down greatly with heat and applied it to hardware cloth it can be very successfully used. The meshes of such cloth must not be greater than eight to the inch. Even with mesh of this size the

tanglefoot must be applied with a stiff brush and only hard rubbing back and forth will keep the meshes open. We believe one screen of this type to be sufficient, but we have also arranged a series of larger mesh screens, one upon another, to act as wind filters, and working upon the principle that if the insect does not strike the first one it will strike the second or the third. We have yet no comparative data on the two types.



A.—Graph showing the numbers of lice caught during the spring period of abundance. March, 1929. The lice are shown in hundreds per hour. It should be borne in mind that the flow is not continuous throughout the day. Most of the records were taken about one or two o'clock in the afternoon; some as late as six-thirty. The hour of each record is shown.



B.—Graph showing the numbers of lice caught during a winter or intermediate period. December, 1929. The lice numbers are shown in individuals per day.

Fig. 61.—Graphs giving an indication of the relative periodicity of the infestation potential for the section.

Two types of screen have been used, one of them fixed in position with walls upon its perimeter and designed to catch the lice drift from one direction only. The other type we designed with a movable vane allowing it to turn with the wind and for the purpose of obtaining weekly records of all lice at certain points. All of these have been vertical traps. We have also used flat boards of beaver board material, painted white and coated with tanglefoot and placed horizontally. Vertical types are much to be preferred since, if they are so constructed that the air passes through them, one can rely upon getting an accurate check on the movement of lice. The movable form of trap is shown in Pl. 28, fig. 2.

Apart from general interest, the trapping of these wind flying forms has a practical value. Whereas the truck season, as far as lice bearing crops are concerned, is some seven months long, the ordinary grower does not distinguish between periods of greater and lesser danger during these seven months. It is our belief, supported by what we have thus far seen, that the lice form their worst menace chiefly during a spring and fall period. There are lice, of course, constantly present in the country, but in late March and early April the production of winged forms is very high and reaches a high period again in the fall. The actual number of fall lice is somewhat lessened by the scantier crops that are grown at that time. There are many periods such as in December of last year where the number of winged forms decreases to nearly none. Tanglefoot screens registered one or two lice per week (per screen of four square feet) during that time, as against several hundred per day in late spring. (See Fig. 61.)

We have been making every effort to bring growers to a realization of the value of planting crops at those periods when laboratory screen records show an atmosphere clear of winged forms. Obviously by so planting the grower can often times give his crop a several weeks start in growth before being infested by wind drift forms which is practically the only potential source of infestation.

RESULTS SECURED ON THE GIPSY MOTH EXTERMINATION PROJECT IN NEW JERSEY

By A. F. BURGESS, *Melrose Highlands, Mass.*

In July, 1920 a heavy gipsy moth infestation was found at Somerville, N. J., and a decision was reached that extermination work should be undertaken by the Bureau of Entomology in cooperation with the New Jersey State Department of Agriculture and financed by the Government and the State.

A very hurried examination, extending over about two weeks, indicated that the insect was present in an area of about 100 square miles. Funds were secured by using this area as a basis and the work was begun.

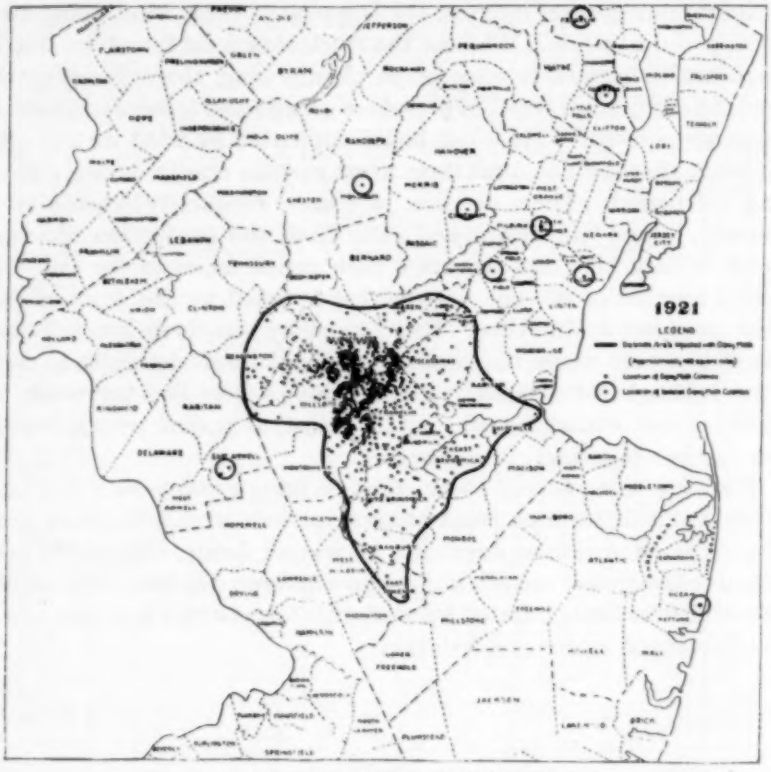


Fig. 62.—Gipsy Moth Project in New Jersey

As a result of careful scouting that was continued throughout the following year the pest was found in an area of over 400 square miles, and in addition nine isolated infested points outside the main area were located. The latter resulted from shipments of trees that had been secured from the worst part of the infested area.

It is now more than nine years since the insect was found in New Jersey, and intensive eradication work has been carried out throughout that period. In 1920 over 3,000,000 egg clusters were treated, and the following summer thousands of acres of tree growth were sprayed. In 1929 only one small colony with less than 100 egg clusters was found, and the site of this colony and the surroundings required spraying. These results were accomplished by carrying on intensive scouting and

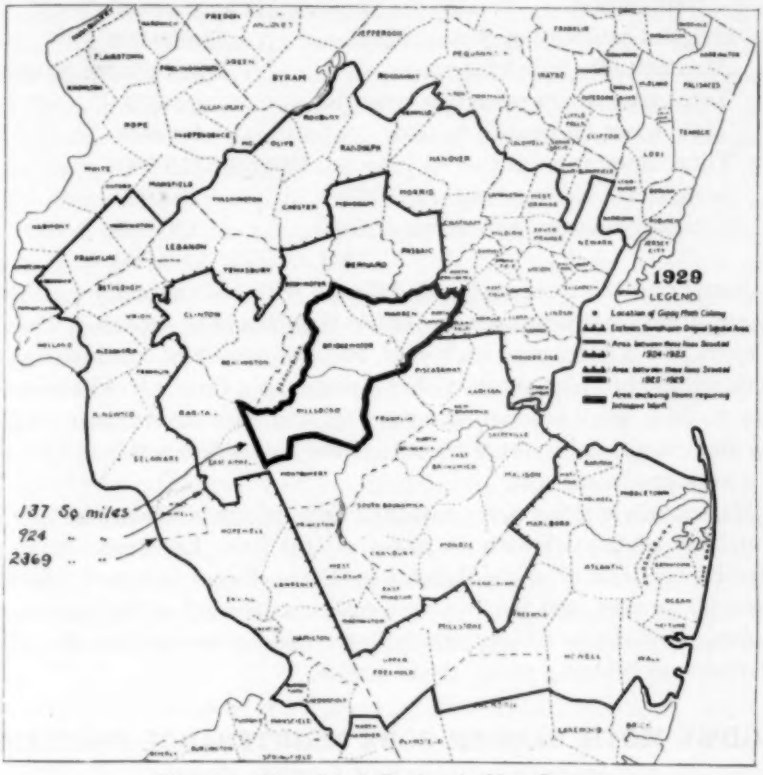


Fig. 63.—Gipsy Moth Project in New Jersey

clean-up work in the badly infested part of the area until the insect was extremely scarce. This was followed by scouting a belt of towns averaging more than 10 miles wide surrounding all of the towns where any infestation had previously been found. During the years that followed, the towns that were farthest removed from the central infestation were intensively scouted, every tree, including those in woodland areas, being examined, and in this way the territory was gradually closed in toward the center.

At the end of the fiscal year 1929, 137 square miles remained to be intensively scouted. The entire area in the State that has been worked is 2,369 square miles, exclusive of the nine isolated colonies that were exterminated within a year or two following their discovery.

The following facts are outstanding:

Original estimate of infested area	100 square miles
Original estimate of time required for extermination	5 years
Original estimate of cost	$1,000,000
Area actually found infested	Over 400 sq. miles
Total area where work was required	2,369 " "
Time spent on project to date	9 years
Total amount expended to June 30, 1929	$2,113,000
Largest annual expenditure (1923)	295,000
Estimated annual expenditure, 1930	120,000
" " " 1931	80,000

Comparing the estimated area infested with that actually found, the expenditures on this project are far less than would be expected. The cost of operation is decreasing each year, and the successful conclusion of the work will be brought about within a reasonable time. It will be necessary to do a small amount of general scouting for several seasons after the area requiring intensive work has been covered, but this can be done at a very moderate cost.

The success of this extermination project, which is the largest that has ever been attempted with an insect of this type, has been due to the effective cooperation of the Federal and State offices concerned, adequate financial support, and the loyal and enthusiastic work of the field organization. Difficulties which frequently seemed insurmountable have been overcome in bringing about these results.

GIPSY MOTH BARRIER ZONE MAINTENANCE PROBLEM

By A. F. Burgess, *Melrose Highlands, Mass.*

In 1923 it was decided that the most effective means of preventing the gradual spread of the gipsy moth throughout New York State and to the States south and west was to establish a zone in which would be carried on such scouting and clean-up measures as would prevent westward movement of this pest.

The area selected averaged about 30 miles in width, extending from the Canadian border to Long Island Sound and embracing over 8,000 square miles. Approximately one-half the area was in New York State

and the balance in Vermont, Massachusetts and Connecticut. The western boundary was the Hudson River and a line extending from its source nearly northward to Canada.

At that time there were known to exist a number of gipsy moth infestations in the zone area and immediate steps were taken to apply exterminative measures. By far the greater part of this area had never been scouted and the utmost efforts of the Federal force in cooperation with the Conservation Department of New York were put forth to determine the conditions that existed throughout the zone. While this zone is the shortest line that can be drawn to use as a barrier and has a very considerable area of fairly level country, still approximately one-half the area is hilly or semi-mountainous and presents many difficulties to an insect control problem.

The natural conditions are not as serious as in the territory to the west which includes the Adirondack and the Catskill Mountains where enormous areas of wild lands and unbroken forests occur, or to the east where the highest ranges of the Green Mountains in Vermont and portions of the Berkshire Hills in Massachusetts extend southward into Connecticut.

Fortunately at the time this work was undertaken, the region immediately east of the zone harbored very few infested areas; and in the territory between the Connecticut River and the Atlantic seaboard the density of infestation had appreciably declined due to the effect of introduced natural enemies, the application of intensive suppression work and high mortality of the eggs of the insect during several particularly severe winters. As the female moths do not fly, the principal means of natural dispersion is due to wind drift of newly-hatched caterpillars, and the possibility of spread is greatly increased in heavily infested areas.

Under these conditions work was started in the Barrier Zone. During the first two years it was possible to scout thoroughly all the town and city trees, the roadsides, farms, and orchards, as well as isolated woodland areas of small acreage. In the case of solid woodland only the borders were examined except in particularly suspicious localities, as long years of experience had shown that dense woodland was rarely found infested unless there were heavily infested regions within a few miles and because in certain sections, particularly in the northern part of the zone, solid stands of conifers, which are less succeptible to the insect than deciduous growth, were common.

This survey, made during the fiscal years 1924 and 1925, clearly indicated that the inauguration of the project was timely, as more than

50 infested areas were found well distributed throughout the zone. A vigorous colony was also found by the Canadian officials in the Township of La Colle which adjoins New York on the international border. Effective treatment was applied to all the infested areas and in the

Fig. 64.—Gipsy Moth Barrier Zone

course of the next three years all of these infestations had been exterminated. Had this work been postponed or delayed, large areas in eastern New York would have become infested. Some of these colonies were located near the western boundary of the zone, and contiguous

territory outside the zone was examined in 1927 as a precautionary measure. Three colonies were found at and directly west of Kingston, N. Y. The value of this work is evident as it made possible the prompt extermination of these outbreaks. Several groups of towns were also examined which adjoined the zone on the east in Vermont and Connecticut. Three vigorous colonies were found in towns adjoining Rutland, Vt., which would have subjected the adjoining area to reinfestation if cleanup work had not been applied without delay

During the fiscal year 1927 only 21 infested points were found in the entire zone, which was the smallest number since the work began.

The finding of the infestation near Rutland, Vt., caused considerable apprehension that similar infestations might be present east of the zone line which would furnish an opportunity for reinfestation of the region which was being scouted and cleaned. The danger was further increased by the fact that the density of infestation in the territory east of the Connecticut River was greater than during the preceding years.

This led to strong recommendations that work should be done in the towns between the zone and the Connecticut River as far north as Rutland, Vt., in order that any large colonies might be discovered and treated so that spread to the zone would be prevented. Up to the present time no funds have been made available for this purpose.

The following table indicates the condition of infestation east of the zone based on the acreage of defoliation:

1924	825	acres
1925	48,560	"
1926	80,822	"
1927	140,920	"
1928	262,514	"
1929	551,133	"

This increase in defoliation means increase in the possibility of reinfestation of the zone. During the last few years small defoliated areas have occurred in a number of towns west of the Connecticut River. The number of infested locations in the zone has increased each year since 1927. For the year ending June 30, 1929, one hundred and one (101) were found and treated, the greatest number being in southwestern Massachusetts and northwestern Connecticut and in the adjoining territory in New York State. A considerable number of these colonies were found in woodland, and since July 1 particular attention has been paid to scouting all woodland areas in this section of the zone that have not been examined in recent years.

This is slow and laborious work but is the only means of finding and cleaning up this section of the zone which seems to be particularly subject to reinfestation from the east.

About 25% of the proposed scouting work for the fiscal year had been completed November 20, 1929, and 56 infested locations had been found. Whether there will be a corresponding increase in number of infestations as the work progresses cannot be determined at this time.

All infestations found are treated thoroughly in order that spread of the pest may be prevented. This is accomplished by treating the egg-clusters with creosote, by spraying after the larvae have hatched, or a combination of both methods, depending on the local conditions where the infestation is found. The application of tree banding material to keep the caterpillars from reaching the tops of the trees is sometimes advisable as an auxiliary to creosoting or spraying.

The principal problem in connection with the maintenance of the barrier zone under present conditions is to keep this vast area reasonably free from infestation while the insect is increasing in the territory to the east. So long as these conditions continue, the task of maintaining the zone in its present locations is beset with increasing difficulty and unless some protection can be afforded from the continued reinfestation of the territory that is cleaned up, a relocation of the zone in more difficult territory will be the eventual result.

In connection with the zone work, but indirectly related to it, is the pressing need for scouting a section directly east of the barrier zone south of the international line in Vermont and the territory contiguous to the quarantine line in northern New Hampshire and Maine. This work would make possible the relocation of the quarantine line based on the findings. It would also safeguard the shipment of products proceeding from towns that may now be infested, and give an opportunity to release from the quarantined area towns that are not infested.

Another point that might be stressed at this time is the fact that the tremendous battle that is being waged to prevent this insect from becoming widely distributed over the United States is chiefly for the benefit of the States that are not now infested. It is natural to worry most about the dangers that are nearest home. The person who is forced to pay the price of combating insects because they are present and from which he is unable to escape, in time becomes reconciled to the annoyance and expense involved and does not fully appreciate the losses that are accruing each year.

On the other hand, there is usually a lack of interest in dangerous conditions that may exist a long distance from home and a failure to

actively support projects the purpose of which is protective and preventive rather than actual correctional work after the damage occurs.

Those who are familiar with the gipsy moth and its work entertain no doubt that this insect would cause appreciable damage and loss to forest and shade trees in the area west of the Barrier Zone. The Barrier Zone gives the first protection to the central part of New York, New Jersey, and Pennsylvania. The maintenance of this zone by the Federal government and the State of New York has for nearly ten years been the means of confining the infestation of the gipsy moth to the New England area. It has demonstrated the value of this zone in protecting the uninfested regions to the west.

OVIPOSITION OF THE CORN EARWORM MOTH IN RELATION TO NECTAR FLOW OF SOME FLOWERING PLANTS[1]

By J. W. NUTTYCOMBE

ABSTRACT

Studies at Charlottesville, Va., indicate that food is a strong factor in determining the number of eggs deposited by corn ear worm moths (*Heliothis obsoleta* Fab.). These moths feed upon the nectar from the blossoms of a great variety of plants, the overlapping flowering periods of which cover the oviposition period of the moths. Nectar flow from these plants, although greatly curtailed by drought, is apparently never so reduced as greatly to affect oviposition; consequently search must be made elsewhere for factors causing marked disturbances in the normal seasonal abundance of the eggs.

Some observations made at Charlottesville, Va., on the variations in the seasonal abundance of the eggs of the corn earworm (*Heliothis obsoleta* Fab.) have indicated that the abundance or scarcity of the food supply for the moths in nature may be a decided factor in determining the number of eggs deposited during a given period. Thus during an exceedingly dry period the nectar flow might be so slight as to afford little food for the moths, and consequently the number of eggs deposited during such a drought would be greatly reduced.

That the quantity of food ingested does affect the longevity of the moths and the number of eggs deposited by them has long been known. Quaintance and Brues (U. S. Dept. Agr., Bur. Ent. Bull. 50, 1905. "The Bollworm. . .") state that "Abundance of suitable food appears to be a vital necessity for the normal longevity of the moths" and "Oviposition does not really begin until after the female has been able to partake of food."

[1]This work was done under the direction of W. J. Phillips, of the U. S. Entomological Laboratory, Charlottesville, Va.

In an effort to determine the importance of this food factor, more than twenty of the nectar producing plants were studied. An attempt was made to ascertain upon which of these plants the moths fed, and which of them yielded sufficient nectar to materially affect oviposition.

The author has observed moths in captivity, and in nature, feed, or attempt to feed from blossoms of the following plants:

Alfalfa (*Medicago sativa* L.)
Button-bush (*Cephalanthus occidentalis* L.). (In nature.)
Catnip (*Nepeta cataria* L.).
Cone-flower (*Rudbeckia* sp.).
Cowpea (*Vigna sinensis* L.). (In nature.)
Daisy (*Chrysanthemum* sp.).
Dog-fennel (*Anthemis cotula* L.).
Erigeron (*Erigeron* sp.).
Hop clover (*Trifolium agrarium* L.).
Horse-nettle (*Solanum carolinense* L.)
Indian hemp (*Apocynum cannabinum* L.).
Joe-Pye weed (*Eupatorium purpureum* L.) (In nature.)
Milfoil (*Achillea millefolium* L.)
Milkweed (*Asclepias syriaca* L.).
Rabbit-foot clover (*Trifolium arvense* L.).
Red clover (*Trifolium pratense* L.).
Sumac (*Rhus* sp.).
White clover (*Trifolium repens* L.).
Wild astor (*Aster* sp.). (In nature.)
Wild carrot (*Daucus carota* L.).
Wild onion (*Allium vineale* L.).
Wild vetch (*Vicia* sp.)

Fifty-three female moths were used in an attempt to determine the effect of food, as found in nature, upon the number of eggs deposited. The female moths, together with males, were placed in glass cylinder cages covered by cheese cloth. Cut blossoms of the food plant to be tested were placed in a vase and then introduced into the cage, and thereafter replaced daily by fresh blossoms. All tests were made during the normal flowering periods of the plants as shown in Figure 65. In all cases, except that of goldenrod, the moths fed, or attempted to feed, several times each day. Conditions of temperature, humidity, etc., were approximately the same in all cages used. In this way 16 different food groups were tested. In Table 1, which follows, the plants are arranged in the order of the number of eggs deposited, from higher to lower. The average number of eggs per moth and the average longevity of the females segregated with each food group are also shown.

Although the actual amount of nectar available under these conditions can only be estimated from effect upon the number of eggs deposited, the data obtained from these studies are indicative that food is a decided factor in the determination of the number of eggs deposited. The fact that few or no eggs were obtained from moths on several of the plants tried as food does not necessarily indicate that these plants may not supply nectar for the moths in nature. The evidence here adduced is merely not positive that they do supply nectar for moths. On the other hand, several of the plants considered in Table 1 quite evidently yielded sufficient food to increase materially the number of eggs de-

posited. Among this latter group may be listed alfalfa, red clover, joe pye weed, milk weed, indian hemp, white clover, daisy, and horse nettle.

TABLE 1. EXPERIMENT TO DETERMINE EFFECT OF THE PRESENCE OF BLOSSOMS OF VARIOUS FOOD PLANTS UPON THE NUMBERS OF EGGS DEPOSITED AND THE LONGEVITY OF CORN EARWORM MOTHS

Food plant	Number of female moths	Aver. Number of eggs	Aver. length of life (days)
Alfalfa	3	582	8½
Red clover	5	477	7
Joe-Pye weed	1	430	9
Milkweed	2	365	8
Indian hemp	4	354	9
White clover	4	328	8
Daisy	5	254	6½
Horse nettle	2	242	6
Wild onion	2	185	10
Wild vetch	2	158	9½
Erigeron	4	85	8
Milfoil	3	63	8½
No food	9	53	7
Wild carrot	2	28	7
Sumac	3	14	6
Golden-rod	2	0	6½

The studies covered in this paper were made between June 1 and October 3 of 1927 and 1928. Figure 65 gives a list of some of the plants occurring in the vicinity of Charlottesville which might furnish more or less food for moths, the probable limits (within the periods of study) of the flowering period of each plant, and the names of other insect groups which were observed to feed at the flowers. Quite naturally the flowering periods and the nectar yield of each species are dependent to a great extent upon the nature of the season. The limiting dates for the table are those for the relatively small areas under observation and are probably not absolutely inclusive for this region.

Surveys made in lowlands about three miles outside of Richmond, Va., during 1927 and 1928, showed that the nectar yielding plants there were substantially the same species as those found at Charlottesville. The most important exception was the button bush (*Cephalanthus occidentalis* L.) which, at Richmond, furnishes an extremely abundant supply of nectar between July 10 and August 5 (limits for 1928). This plant was not observed at Charlottesville during these studies.

No attempt was made to determine the flowering limits of soy beans and cow peas and a few other cultivated plants because different fields of these are in bloom continuously from early July until frost, depending on the planting date. Moths were observed feeding on cow peas (*Vigna sinensis* L.) in large numbers.

In addition to the determination of the flowering limits of the possible nectar plants an attempt was made to estimate whether or not nectar was being secreted throughout the season, particularly during periods of temporary drought. Honey bees and bumble bees (in the case of red clover) were captured while visiting the plants listed below and their honey stomachs examined. These examinations were made throughout the summer, a week or ten days apart and several (usually five) bees were used for each examination. Bees from Erigeron, sumac, milfoil, daisy, rabbit-foot clover, white clover, red clover, indian hemp, water hemlock, iron weed, Joe-Pye weed, wild onion, cone flower, and golden rod were examined during the period within which the plants flowered. The data thus collected showed that, even though the nectar flow was curtailed during dry periods, there was always a considerable quantity of nectar available, particularly in the bottomlands where the drought was less severe. The bottomlands considered were adjacent to the uplands and the difference in elevation rarely exceeded 100 feet. The flowering periods of the various plants of the series are shown in Figure 65 and it may be noted that the periods represented by the plants from which bees were examined cover the entire period between June 6 and October 3. In view of the fact that the moths are extremely strong fliers and might, if necessary, migrate to the lowlands for feeding if there were a dearth of nectar from upland flowers, it seems unlikely that there is ever such a scarcity of nectar as would seriously affect the food supply of the moths and thus materially reduce the number of eggs deposited.

In addition to the plants mentioned in this paper, there are numerous other species which, though less plentiful, in agregate would yield much nectar. Probably the bulk of these plants fall in the families Leguminosae, Compositae, and Labiatae.

These studies indicate that for this locality:

1. Food is an important factor in determining the number of eggs deposited by the moths.
2. The moths feed on the nectar from a great variety of plants.
3. The overlapping flowering periods of these plants cover the period during which oviposition occurs.
4. Nectar flow, though greatly curtailed by drought, is apparently never so reduced as to greatly affect oviposition.
5. And, consequently, we must look elsewhere for factors causing marked disturbances in the normal seasonal abundance of the eggs.

Fig. 65.—A list of some of the plants for the vicinity of Charlottesville which might furnish food for corn earworm moths, the probable limits of the flowering period and other insect groups which were observed to feed at the flowers.

SECOND REPORT ON SOME OF THE MORE IMPORTANT INSECTS CAPTURED IN CODLING MOTH TRAP BAITS, YAKIMA, WASH., 1927–28[1]

By M. A. YOTHERS, *Associate Entomologist, Deciduous Fruit Insect Investigations, U. S. Bureau of Entomology, Yakima, Wash.*

ABSTRACT

In experiments with trap baits for capturing the codling moth, *Carpocapsa pomonella* L., many other insects were captured. Observations on the earliest and latest appearances and times of maximum numbers are presented for some of the more important of these, such as the clover-hay moth, *Hypsopygia costalis* Fab., the oblique-banded leaf-roller, *Archips rosaceana* Harr., the Chrysopas and the Noctuids.

EXPERIMENTS IN 1927

Experiments with codling-moth trap baits in 1927 were carried on in three orchards, each of which differed greatly from the others in its cultural condition and in the care taken of it with reference to the codling moth.

THE J. H. WRIGHT ORCHARD. The test in the J. H. Wright orchard consisted of the use of 100 3-pint enameled kettles of molasses ferment,[2] one in each tree, and their operation from May 16 to September 18. The kettles were suspended from the under side of limbs in the top third of 25-year-old apple trees. In this tract, and in the remainder of the orchard surrounding it on three sides, were occasional bunches of alfalfa and sparse miscellaneous weeds, but not enough of all to constitute a real cover crop. The codling moth infestation had been considerable during previous years, but this season, owing perhaps to an extra heavy spraying program, the infested fruit was probably not over 10 per cent of the crop. The crop of fruit was extremely light.

These baits, placed out on May 16 and examined for insects regularly every 5 days to September 18 (Table 1), caught the first codling moths by the time of the first examination, May 21, the maximum number for the spring brood June 20, and the maximum number for the combined late broods about the middle of August. After the termination of the experiment, September 18, probably very few codling moths were present.

[1]The first report on this subject appeared in the Journal of Economic Entomology, Volume 22, Number 5, pp. 805–811, October, 1929.

[2]Molasses 1 part, water 15 parts + yeast (1 cake, ½ oz., to the gallon).

TABLE 1. RECORD OF SOME OF THE MORE IMPORTANT INSECTS CAPTURED IN ONE HUNDRED TRAP BAIT PANS, J. H. WRIGHT ORCHARD, YAKIMA, WASH., 1927

Date	Codling moths	Noctuids	Chrysopa spp.	Clover-hay moths	Leaf-rollers (Archips rosaceana)
May 21	12	351	12	—	—
26	50	249	16	—	—
31	26	243	16	—	—
June 5	332	200	54	2	—
10	108	199	22	40	—
15	370	213	27	15	6
20	413	249	53	70	13
25	154	214	42	106	11
30	68	149	40	78	5
July 5	180	374	93	268	8
10	166	687	73	638	12
15	89	484	57	615	6
20	40	545	71	1,019	9
25	88	810	223	1,573	10
30	192	808	448	944	4
Aug. 4	273	803	391	761	—
9	611	1,291	775	992	—
14	208	1,182	463	393	—
19	459	1,091	629	371	12
24	470	2,773	953	223	—
29	129	4,512	1,048	74	—
Sept. 3	52	4,363	688	75	—
8	46	3,875	368	104	—
13	5	2,845	180	128	—
18	70	3,165	586	148	66
Total	4,611	31,675	7,328	8,637	162

Noctuids were captured in considerable numbers from the start, but in increasing numbers throughout the remainder of the season, there being nearly as many at the end of the test as at the time of the maximum capture, about the last of August.

Lace-wing flies, *Chrysopa* spp., were captured in very small numbers until about July 25, after which they were present in considerable numbers.

The clover-hay moth, *Hypsopygia costalis* Fab., did not appear in the baits until June 5, after which it was captured in increasing numbers to the end of the test.

The oblique-banded leaf-roller, *Archips rosaceana* Harr., appeared a little later than the clover-hay moth or on June 15, with only occasional captures throughout the season.

THE C. H. HINMAN ORCHARD. The C. H. Hinman orchard, consisting of 5 acres of 20-year-old apple trees, was bounded on two sides by other orchards. It had a heavy cover crop of alfalfa and a luxurient growth of miscellaneous weeds. The two bounding orchards and the two additional sides were all in alfalfa. It had been badly infested with the

codling moth (about 35 per cent) the previous season, but a very efficient spray program reduced the percentage of infested fruit to probably less than one-fourth of 1 per cent.

TABLE 2. RECORD OF SOME OF THE MORE IMPORTANT INSECTS CAPTURED IN 60 TRAP BAIT PANS, C. H. HINMAN ORCHARD, YAKIMA, WASH., 1927

Date	Codling moths	Noctuids	Chrysopas	Clover-hay moths	Leaf-roller (Archips rosaceana)
May 5	—	—	1	—	—
7	—	3	0	—	—
9	—	15	2	—	—
10	—	12	0	—	—
11	—	17	0	—	—
14	16	63	2	—	—
17	129	54	3	—	—
20	2	83	0	—	—
23	2	180	8	—	—
26	9	40	3	—	—
29	3	135	0	—	—
June 1	78	382	29	—	—
4	334	151	45	5	—
7	194	190	19	5	—
10	56	178	14	25	—
13	79	218	10	79	5
16	220	326	71	322	14
19	191	236	54	267	18
22	147	293	83	572	7
25	37	236	14	316	1
28	14	229	64	681	1
July 1	24	262	102	1,252	4
4	41	129	64	1,279	22
7	48	256	90	1,498	11
10	59	157	93	2,465	2
13	34	222	41	2,735	5
16	23	232	48	2,760	12
19	42	187	45	4,055	7
22	26	192	47	4,605	1
25	40	142	66	3,615	3
28	79	199	76	4,640	0
31	183	235	97	4,885	0
Aug. 3	156	515	123	4,430	2
6	568	506	208	3,526	2
9	503	652	290	3,015	3
12	200	632	205	1,330	1
15	214	848	260	1,441	1
18	637	1,745	598	1,685	2
21	597	3,420	865	1,030	0
24	208	2,787	367	428	0
27	64	3,820	382	458	0
30	25	3,262	259	271	0
Sept. 2	24	2,940	289	375	0
5	32	3,024	255	732	0
8	7	1,666	138	126	0
11	1	1,228	75	159	0
Total	5,346	32,299	5,505	55,067	124

The trap baits were installed May 4, examined every 3 days (after the daily examination of the first few days), and discontinued September

11. Various kinds and strengths of baits were used in the 60 3-pint enameled kettles, but even so there is a marked uniformity of results, in so far as dates of occurrence are concerned, with the Wright orchard where molasses ferment bait was used throughout the season.

Although the baits were placed May 4, no insects of any kind, except one Chrysopa, were captured on the 5th. Codling moths began to appear May 14, reaching the maximum for the spring brood about the first or second week of June. From June 22 to late July comparatively few codling moths were caught, but there was a considerable increase from July 31 to August 24, after which there was a gradual decline to the end of the season.

Noctuids began to appear shortly after the test was started, or on May 7, after which they were present in considerable numbers until the middle of August, when they came in much greater numbers even to the end of the experiment.

TABLE 3. RECORD OF SOME OF THE MORE IMPORTANT INSECTS CAPTURED IN 56 TRAP BAIT PANS, WEST BROADWAY, YAKIMA, WASH., 1927

Date	Codling moths	Noctuids	Chrysopa spp.	Clover-hay moths
July 28	199	222	32	1,130
30	264	431	90	2,425
Aug. 1	599	531	171	2,920
3	419	845	172	1,775
5	995	800	237	1,185
7	965	694	236	836
9	921	702	243	1,070
11	678	935	199	481
13	11*	621	75	142
15	422	767	171	415
17	515	1,233	245	807
19	485	1,610	389	830
21	492	1,617	198	368
23	489	2,579	159	358
25	93*	1,754	75	247
27	56	2,197	84	246
29	40	2,428	29	167
31	10	1,559	21	83
Sept. 2	55	2,094	24	208
4	15	1,515	5	309
6	56	1,809	35	378
8	0	827	1	35
10	2	1,620	7	211
Total	7,781	29,390	2,898	16,626

*A sudden drop in the daily mean temperature on August 11 and 12, from 78° F. to 56.5° F., caused a tremendous falling off in the number of each kind of insect captured, especially the codling moth, which is apparently more keenly responsive to such temperature changes than any of the other insects caught. This was also true, although in a somewhat less degree, on August 23 and 24, when the daily mean temperature fell from 74° F. to 63° F.

Chrysopas appeared from almost the start, then in greater numbers throughout June and July, and in still greater numbers throughout August, with a sudden decrease after September 5–8.

The clover-hay moth did not make its appearance until June 4, after which it increased very rapidly, becoming most abundant in the latter half of July, and decreasing after the first week of August.

No leaf-rollers were caught until June 13, after which a few were captured at intervals until August 18.

THE WEST BROADWAY ORCHARD. The West Broadway orchard was a neglected, entirely uncared for orchard. There was a fair cover crop of alfalfa and miscellaneous weeds. The fruit was 100 per cent wormy and so no effort was made to harvest it. Several kinds of baits were tested. Tests were begun July 26 and terminated on September 10.

Records of captures of codling moths showed results similar to those made in the other two orchards—the moths were on the increase in late July, reached maximum abundance during the first week of August, and their numbers suddenly dropped off after August 23.

Noctuids were on the increase from the beginning of the test until about the last of August, after which there was a decrease, although they were still attracted in large numbers up to the end of the experiment.

Chrysopas were also on the increase from the beginning of the experiment until about the 19th of August, after which there was a pronounced decline to the end of the test.

The clover-hay moth was at about its maximum during the first few days of the test, and decreased in numbers, although more or less irregularly, after about August 9.

EXPERIMENTS IN 1928

The main experiments in 1928 were conducted in the A.B. Haueter orchard, where 170 traps were operated in 5 acres of old apple trees of several varieties. The orchard had an alfalfa cover crop and was surrounded on all four sides by other orchards, three of which had cover crops and the fourth, clean cultivation. Owing to improper care in previous seasons, and to the fact that this season it had only one or two careless applications of spray for the spring brood, there was a tremendous codling moth infestation during the tests, and no fruit was harvested.

Tests were not begun until July 24, consequently no records are available for the first half of the season. This year, records of only the codling moth and the clover-hay moth were made.

On July 26, at the time of the first examination, both codling moths and clover-hay moths were abundant and continued so, with variations, until about the beginning of the second week in September, after which there was a distinct and abrupt falling off of both species. While both species were captured in greater numbers at the first and second examinations than at any other time, this may be partly due to captures at these dates of accumulated insects.

TABLE 4. NUMBER OF CODLING MOTHS, *Carpocapsa pomonella* L., AND CLOVER-HAY MOTHS, *Hypsopygia costalis* FAB., CAPTURED IN TRAP BAITS, A. B. HAUETER ORCHARD, YAKIMA, WASH., 1928

Date	Codling moths	Clover-hay moths	Date	Codling moths	Clover-hay moths
July 26	5,738	2,930	Aug. 21	5,171	330
28	7,191	2,874	23	3,644	477
30	6,592	2,040	25	5,158	704
Aug. 1	3,101	1,538	27	2,101	413
3	2,194	600	29	1,126	400
5	4,459	562	31	2,294	930
7	5,305	1,426	Sept. 2	3,216	1,046
9	5,178	1,492	4	3,200	797
11	3,865	1,140	6*	2,078	547*
13	3,005	552	8	492	85
15	3,194	233	10	793	153
17	5,661	892	12	470	74
19	6,588	558	14	22	101
Total				91,836	22,894

*The number of bait pans operated up to and including this date was 171; thereafter, it was 143.

Table 5 summarizes the records of earliest, and maximum and latest captures of the different kinds of insects in the several orchards in the years 1926, 1927, and 1928. The records for 1926 are taken from the author's first report on this subject, previously cited. The spring season of 1926 was extremely early and consequently not only the codling moth but each of the other insects appeared earlier that year than in other years.

In addition to the foregoing insects there were also many small Diptera, a few Vespas, large Diptera, grass moths, syrphus flies, butterflies, Hemerobiids, Membracids, and an occasional box-elder leaf roller (*Cacoecia semiferana* Walk.), a species of Peronea, and the apple pandemis (*Pandemis pyrusana* Kearf.).

TABLE 5. TIME OF EARLIEST AND LATEST APPEARANCE AND MAXIMUM NUMBERS, BY YEARS AND ORCHARDS, OF SOME OF THE MORE IMPORTANT INSECTS CAPTURED IN CODLING MOTH TRAP BAITS, YAKIMA, WASH.

Year	Orchard	Codling moth: Spring-brood moths: Date of First	Codling moth: Spring-brood moths: Date of Max.	Codling moth: Spring-brood moths: Date of Latest	Codling moth: Late-brood moths: Date of First	Codling moth: Late-brood moths: Date of Max.	Codling moth: Late-brood moths: Date of Latest	Clover-hay moth: Date of First	Clover-hay moth: Date of Max.	Clover-hay moth: Date of Latest	Chrysopas: Date of First	Chrysopas: Date of Max.	Chrysopas: Date of Latest	Noctuids: Date of First	Noctuids: Date of Max.	Noctuids: Date of Latest	Oblique-banded leaf-roller: Date of First	Oblique-banded leaf-roller: Date of Max.	Oblique-banded leaf-roller: Date of Latest
1926	Wright[1]	Apr. 26	May 14–June 7	July 4	July 4	Aug. 15	Sept. 20	May 29	July 10	Sept. 23	Apr. 23	Sept. 5	Sept. 23	Apr. 19	Sept. 11	——	May 20	——	Sept. 17
	Wright[2]	Apr. 26	——	July 4	——	——	——	May 26	——	——	Apr. 26	——	——	Apr. 23	——	——	May 14	——	——
	Wright[3]	——	——	——	——	Aug. 9–15	Sept. 20	——	July 13–22	Sept. 23	——	Aug. 3–Sept. 5	Sept. 23	——	Sept. 5	——	——	——	Sept. 20
1927	Wright	May 15–21	June 20	July 20	July 5	Aug. 9	Sept. 18	June 5	July 25	——	May 15–21	Aug. 29	——	——	Aug. 29–Sept. 3	——	June 15	——	——
	Hinman	May 14	June 4–16	June 28–July 16	July 4	Aug. 18	Sept. 11	June 4	July 31	——	May 5	Aug. 21	——	May 7	Aug. 27	——	June 13	——	Aug. 18
	Broadway	——	——	——	——	Aug. 5–9	Sept. 10	——	Aug. 1	——	——	Aug. 19	Sept. 10	——	Aug. 23–29	——	——	——	——
1928	Haueter[4]	——	——	——	——	July 28–Aug. 19	——	——	July 26	——	——	——	——	——	——	——	——	——	——
	Haueter[5]	——	——	——	——	July 28	——	——	July 26	Sept. 8	——	——	——	——	——	——	——	——	——
	Haueter[6]	——	——	——	——	July 28–Aug. 19	——	——	July 28	Sept. 6	——	——	——	——	——	——	——	——	——

[1]Apple-ferment block operated continuously throughout the season.
[2]Observations from 11 separate sets of experiments running through parts of the spring brood only.
[3]Observations from 2 experiments running throughout the late broods only.
[4]Observations from the whole series of experiments running through the late broods after July 24.
[5]and [6]Observations from check rows, consisting of baits operated without change of kind of material.

THE "SPITTING" HABIT OF LEPIDOPTEROUS LARVAE[1]

By HERBERT J. PACK[2]

ABSTRACT

Certain Lepidopterous larvae including *Zophodia grossulariae* Riley, *Anarsia lineatella* Zeller, *Spilonota ocellana* (D. and S.) and *Recurvaria nanella* Busck were found invariably to reject the first mouthfuls of food when entering the host plants. *Hulstea undulatella* Clemens, *Autographa californica* (Speyer), and a species of *Loxostege*, all of which differ from the above mentioned in being external feeders, did not reject or "spit" food.

Probably too little attention has been given to the feeding habits of very young larvae. Smith (1926) called attention to the interesting and regular habit of the newly hatched larvae of the codling moth, *Carpocapsa pomonella* (Linn.), of rejecting the first mouthfuls of food in effecting their initial entrance into the apple. Several earlier workers including Card (1897), Slingerland (1898), Siegler and Plank (1921) had noted the habit, but, as Smith remarks, "its significance has been almost entirely overlooked ————." Peterson (1929) working with the oriental peach moth, *Laspeyresia molesta* Busck, reports that the young larvae of that insect have a similar habit. He says, "the first mouthfuls are not consumed, but are set to one side. After the larva has its head deeply buried in the gouged out cavity it starts to feed."

During the past summer while detailed life history observations of the gooseberry fruit worm, *Zophodia grossulariae* Riley, were in progress, it was noted that not only the newly hatched individuals, but larvae of all instars rejected food when entering the fruit.

The newly hatched larva crawls around for a length of time varying a great deal in different individuals and finally begins to eat into the fruit. The first mouthfuls are cast aside. Frequently the larva carries the rejected material some distance from the point of entrance before casting it away. Later as it tunnels farther into the berry it backs out and casts the food just outside the hole. During the whole process until the body has disappeared entirely the larva, so far as could be observed, ate none of the food. Later, larvae removed from berries in which they had been feeding and placed on new fruit repeated the "spitting" process. Whenever a larva of any instar, naturally dislodged or mechanically removed from the insde of a berry, attempted to gain entrance into another fruit it rejected the first mouthfuls. This practice was observed

[1]Contribution from Department of Entomology, Utah Agricultural Experiment Station.

[2]Entomologist. Publication authorized by Director, 15 December, 1929.

NOTE: Dr. H. J. Pack died suddenly on January 5, 1930.

in numerous larvae of all instars except the last. Here only one observation was made, but the practice was unaltered. The method related above was followed regardless of the length of time which the insects had been feeding previously. Some of the older larvae began to retain food, however, when only the head had disappeared within the fruit, although, as a rule the greater part of the first half of the body was buried in the fruit before the rejection of food ceased.

Observations of the larvae of the bud moth, *Spilonota ocellana* (D. and S.), revealed the fact that here too the "spitting" habit was practiced. Observations of this insect covered only the newly hatched larvae. Pieces of the surface leaf tissue are removed and cast aside. Rather soon the larva begins to spin a fragile covering over its body encompassing the spot from which the leaf surface has been removed and not until it is amply covered does it begin to retain the food.

The newly hatched larvae of *Recurvaria nanella* Busck eat and spin alternately and reject all food until they have acquired protection within the mine in the leaf. Once this insect gains entrance it remains within the leaf until it abandons its mining habit in the fall and migrates to the wood to make its hibernaculum. In the spring the larva becomes a leaf feeder and observations to determine whether or not it then "spits" its food have not been made.

Observations of the peach twig borer, *Anarsia lineatella* Zeller, were confined almost entirely to the newly hatched larvae, which begin to eat either into the twig or fruit. Most of the observations were of insects entering the twigs. The little larvae work very rapidly and within from five to fifteen minutes have become completely buried in the twig. Invariably in the insects observed the first food was cast out and not until a good part of the body was hidden did the rejection of food cease. Later larvae, when removed from the burrows and placed on fruit sought the stem end or an abrasion, nibbled at the fruit and then cast it aside. No specimen was watched during the entire course of its entrance into a fruit.

The following insects were observed *not* to eject food: *Hulstea undulatella* Clemens, the sugar beet crown borer; *Autographa californica* (Speyer), the alfalfa semi-looper; and a species of *Loxostege*. The first, i.e. the crown borer, when feeding on the leaf and in every instance where its early activities were carried on and observed above the ground, spun over itself a fine covering before beginning to feed to any extent.

It will be noted that all of these observations apply to Lepidopterous larvae. In all cases in which "spitting" was observed the larvae characteristically feed within the host plant or in a sheltering cover. The larvae

which did not reject food feed upon the exterior of the plant except in the case of the sugar beet crown borer which feeds upon the root or leaf from a silken tube which is buried beneath the soil or is on the surface and covered with soil particles.

The full significance of this practice of food rejection or "spitting" can be measured adequately only when the observations cover an increased number of insects. The economic importance of the characteristic as practiced by the observed insects is apparent when the insecticide used is a stomach poison. Obviously the efficacy of the spray is reduced if insects "spit" most of the poisonous outer covering. Quantitative tests to determine just how much poison is ingested even though most of the food is expelled will no doubt result in considerable progress in the problem of control.

Literature Cited

Card, F. W. 1897. Observations on the codling moth. Nebraska Agr. Exp. Sta. Bul. 51:1–50.

Peterson, Alvah. 1929. Some factors that limit artificial control efforts for the oriental peach moth, *Laspeyresia molesta* Busck. Jour. Econ. Ent. 22:108–115.

Siegler, E. H. and Plank, H. K. 1921. Life history of the codling moth in the Grand Valley of Colorado. U.S.D.A. Bul. 938:1–117.

Slingerland, M. V. 1898. The codling moth. New York Agr. Exp. Sta. Cornell Bul. 142:1–69.

Smith, Ralph H. 1926. The efficacy of lead arsenate in controlling the codling moth. Hilgardia 1:403–453.

ADDITIONAL NOTES ON *APHIS POMI* DE G.

By C. R. Cutright, *Ohio Agricultural Experiment Station, Wooster, Ohio*

Abstract

Growing terminals are at least four times as attractive as the non-growing and the aphids located on such produced almost six times as many young.

During a period of several years which has been devoted to research work with *Aphis pomi*, the writer has become much interested in the food conditions that favor this species. The fact that this aphis must have food that is actively growing before it can increase to great numbers has been pointed out by Baker and Turner (1), Lathrop (5), Cutright (3), and Garman (4). These observations have dealt with the species after establishment on terminals and have not considered the reaction that takes place when migrants are locating new food. To test this reaction a given number of twigs were selected, half of which were actively growing while the other half had ceased growth. On each of these twigs there were then placed 6 migrants taken from old colonies.

Four experiments of this nature were conducted and the results are shown in Table 1.

TABLE 1. PERCENT OF MIGRANTS REMAINING ON GROWING AND NON-GROWING TERMINALS AT THE END OF 48 HRS.

	Growing terminals	Non-growing terminals
Experiment 1	33%	12%
Experiment 2	50%	4%
Experiment 3	22%	12%
Experiment 4	8%	0%
Average	28.2%	7.5%

These results with significant odds of 27.5–1 lead us to conclude that the growing terminals were at least four times as attractive to the migrants placed on them as were the non-growing. In the field even more conclusive data has been collected. For example, on the 22nd of July, 1929 when about four-fifths of all terminals had hardened, in a count including 562 terminals, not a single hardened terminal was tenanted by migrants while the actively growing terminals were over 10 per cent infested. Such data has been duplicated many times in the past few years.

The next question that arises is, what effect will food have on the reproduction of migrants after they have selected a feeding place? In conducting the experiments summarized in Table 1 data were taken on this point and this is given in Table 2.

TABLE 2. REPRODUCTION PER INDIVIDUAL MIGRANT ON GROWING AND NON-GROWING TERMINALS

	Growing Terminals	Non-growing terminals
Experiment 1	6.0	.7
Experiment 2	3.3	1.0
Experiment 3	5.4	3.0
Experiment 4	11.0	.0
Average	6.4	1.2

This data with odds of 72–1 shows that the individual migrant located on a growing terminal produces almost 6 times as many young as does one located on a terminal that has ceased growth. Such a difference is indeed significant when the factors governing outbreaks are to be considered. As in the first case, field observations fully confirm the above figures.

Once located on a terminal the amount of reproduction that follows can be correlated directly with the amount of growth that the terminal

makes. This is shown clearly by the following experiment. On June 3, 1929, five migrants were placed on a growing terminal of each of six young potted apple trees that were held under wire screen. The following day the migrants were removed and ten newly born aphids were left on each terminal. At the end of 31 days the terminal growth was measured and the number of aphids on it counted. In all instances some aphids had migrated to other terminals and these together with the growth of the terminal are included in the figures in Table 3.

TABLE 3. AMOUNT OF TERMINAL GROWTH AND NUMBER OF INDIVIDUALS PRODUCED FROM A GIVEN ORIGINAL NUMBER OF APHIDS

Tree	Centimeters growth	No. of aphids	
1	5.5	322	
2	6.0	368	
3	7.2	460	Odds above
4	9.6	621	2221–1
5	20.8	1150	
6	25.1	1181	

When the factors of vegetative growth and aphid reproduction are correlated, the remarkably high measure of association or correlation coefficient of .9703 is the result. Significant odds of 2221–1 may be calculated from this coefficient. In the field, luxuriously growing terminals are frequently noted where the aphid population numbers between 2,000 and 4,000. Close by are less vigorous terminals where the population will number only a few hundred. In view of the above figures there is little doubt that these populations came from about the same original numbers and that the great difference in final population is due to difference in food.

A further interesting fact regarding the effect of food on aphids already established on hardened foliage has been noted. About mid July some terminals on potted trees hardened, the foliage being infested with apterous *pomi*. From this time, unless attacked by predators, this population maintained itself almost intact till early September and some individuals lived even longer. During this period of almost eight weeks, covering high temperature intervals of July and August, such aphids seemingly did not grow and certainly did not reproduce. We have no experiments to confirm this idea but there is little doubt that such individuals if provided with suitable food would grow and reproduce. Therefore, this population, the condition of which certainly resembled that of aestivation, may be the source of infestation of water sprouts in late August and September.

All data included in this paper has a decided economic trend, in that growth condition as it exists in the orchard, particularly after mid July,

may be used with confidence as a basis for predicting the future course of an outbreak of green apple aphis.

BIBLIOGRAPHY

BAKER, A. C. and TURNER, W. F. 1916. Morphology and Biology of the Green Apple Aphis. Jr. Agr. Res., Vol. 5, p. 955–993.

CUTRIGHT, C. R. 1928. The Green Apple Aphis. Proc. the Ohio State Hort. Soc., pp. 106–114.

CUTRIGHT, C. R. and HUBER, L. L. 1928. Growth Condition of the Host as a Factor in Insect Abundance. Annals. Ent. Soc. of America, Vol. XXI, pp. 147–153.

GARMAN, PHILIP. 1927. Weather Conditions Accompanying the Aphid Outbreak in Connecticut in 1927. 27th Rpt. State Entomologist of Conn., p. 271–276.

LATHROP, F. H. 1923. The Influence of Temperature and Evaporation upon the Development of *Aphis pomi*. DeG. Jr. Agr. Research, Vol. 23, p. 969–987.

LATHROP, F. H. 1928. Biology of Apple Aphids. Ohio Jr. of Science, Vol. 28, pp. 177–204.

THE INFLUENCE OF RESISTANT APPLE SCIONS ON THE SUSCEPTIBILITY OF NON-RESISTANT STOCKS WITH RELATION TO WOOLLY APHID ATTACKS[1]

By C. L. FLUKE, *University of Wisconsin*

ABSTRACT

Northern spy has long been known as an apple variety fairly free from woolly aphid attack. The problem was to determine the influence this variety had on susceptible stock when used as a top graft or as an intermediate scion. The results of this study show that there is very little if any positive influence.

The woolly aphid of apple is a constant pest of apples. It attacks both the parts above ground and the roots but does its most damage to the roots. Excrescences or galls are formed on the roots which interfere with the development of the trees, usually causing stunted trees which produce small and inferior fruit.

Le Pelley,[2] studying the resistance of apple to the woolly aphid, concluded that there is no definite results in favour of the belief that there is an interaction between stock and scion with respect to woolly aphid resistance. He indicated the probability that if there is influence in this respect it is slight. The tests reported here confirm these conclusions.

METHOD OF PROCEDURE. Young trees with various combinations of stock and scion were planted in large pots and then placed in the green-

[1]This problem was suggested by Dr. R. H. Roberts of the Horticultural department of the University of Wisconsin.

[2]R. Le Pelley, Studies on the resistance of apple to the woolly aphis (Eriosoma lanigerum H.). Jour. Pomol. and Hort. Sci. *6* (1927) No. 3, pp. 209–241. pl. 1. Bibliog.

house. To secure infestations infested trees were tied to the test trees or only placed near them. In both cases the test trees were readily infested with the aphids.

The following diagram illustrates the combinations used in the tests.

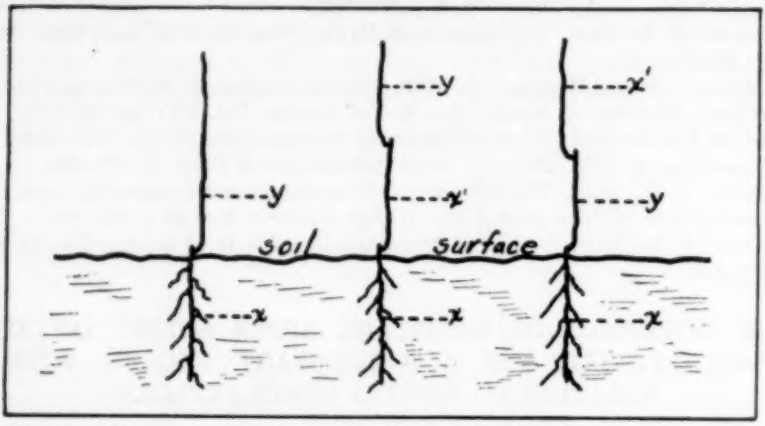


Fig. 66.—Diagram illustrating root and scion combinations. x = susceptible root stock, y = resistant scion, x′ = susceptible scion.

In the above diagram x was always a susceptible root stock, either seedling or malling stocks; x^1 was a susceptible scion; Wagner, Wealthy, Hyslop, and Winesap; y was a resistant scion; Spy or Whitney. Thus, will y interact with either x or x^1 so that they will become resistant to aphid attack?

Whitney is classed as semi-resistant as it did not support aphid colonies readily; although in time colonies appeared at the buds but never became as numerous or large as in the purely non-resistant strains. Northern Spy was not entirely free from attack.

Results. The following table gives the results of these tests and shows clearly that the use of a resistant scion such as Northern Spy does not affect the susceptibility of the root stock to aphid attack. Nothing would then be gained by using a resistant variety as an intermediate scion to produce resistance to woolly aphids either in the scion above it or the root stock below.

Large aphid colonies were produced upon all the susceptible roots and scions; only Spy and Whitney to a limited extent, were free from infestations. The susceptible stocks and scions supported just as large colonies of woolly aphids when combined with Spy or Whitney as when used alone, as in test numbers 5, 12, 15, 16, and 17. Unfortunately no trees were available with Spy as an intermediate scion.

TABLE OF RESULTS OF WOOLLY APHID STUDIES

Test No.	Date Started	Date of Results	Scion and Stock Combination	Results
1	Oct. 16	Oct. 30	Root-malling No. 1, top-spy	Large colony on roots, a few small colonies on spy
2	"	Nov. 20	Root-seedling, top-spy	Extremely large colony on the roots, no colonies on spy
3	"	"	Root-seedling, top-Whitney	Rather large colony on roots, a few small colonies on top
4	"	Oct. 30	Root-malling No. 1, top-Whitney	One large colony on roots, 6 small ones on Whitney
5	"	"	Malling No. 1—root and top	3 trees and all were almost completely covered with aphids
6	Oct. 30	Nov. 20	Root-seeding, top-spy	Several large colonies on roots, only one small colony on spy
7	"	"	Root-seeding; top-Whitney	Large colonies on roots amd considerable on the top. This tree later died
8	"	"	Root-seeding; top-Whitney	Large colonies on roots and branch from roots, top with only small colonies at the buds
9	"	"	Root-malling No. 1, top-spy	2 trees—roots with several large colonies, only a few small ones on the spy
10	Oct. 31	"	Root-malling No. 1, mid section—Whitney-, top-winesap	Small colonies on all sections, larger colonies later developed on the winesap and malling
11	Nov. 20	Dec. 13	Root-malling No. 1, mid section-Whitney, top-winesap	Top with large colonies, mid section with a small colony, root with one large colony
12	Nov. 2	Nov. 20	Root-seedling, mid section-malling No. 1, top-wagner	Numerous small colonies on roots, mid section, and top
13	Nov. 3	Dec. 13	Root-seedling, mid section-hyslop, top-Whitney	Colonies large and well scattered on hyslop, very few on Whitney, heavy on the roots. 2 trees
14	Nov. 20	Dec. 13	Root-seedling, top-Whitney	Large colony on roots, small ones on Whitney
15	"	Jan. 8	Root-seedling, top-malling No. 1	Numerous colonies on both seedling roots and malling top. 2 trees
16	"	Dec. 13	Root-malling No. 1, top-seedling	Large colony on malling roots, one large and two small colonies on seedling top
17	Dec. 13	Dec. 28	Root-seedling, top-seedling	10 trees, all heavily infested, all died within two months

THE MITE, *LINOPODES ANTENNAEPES* BANKS, AS A PEST OF CULTIVATED MUSHROOMS, WITH PRELIMINARY TESTS TOWARD CONTROL

By O. E. GAHM, *U. S. Bureau of Entomology*

ABSTRACT

The mite *Linopodes antennaepes*, heretofore unrecorded as a pest of mushrooms, was first found attacking cultivated mushrooms in Pennsylvania during March, 1929. The mite was found later in the year causing commercial damage in ranges of mushroom houses at Ashtabula, Ohio, and Naperville, Illinois and in one of the sandstone caves at St. Paul, Minnesota.

The injury produced by this mite is characterized by a partial destruction of the "root system" and a decided constriction of the sporophore at the base. Thermal-death-point experiments show that the mites can not withstand a temperature of 100.4°F., for a half hour exposure in a constant temperature chamber with an accompanying relative humidity of 89 per cent.

Control by steaming the surface of the compost heap was practiced with good results.

During March, 1929, while inspecting mushroom houses in Pennsylvania, the writer found a mite causing commercial damage in a house near Kennett Square. This mite has been determined by Dr. H. E. Ewing of the Bureau of Entomology, as *Linopodes antennaepes* Banks.

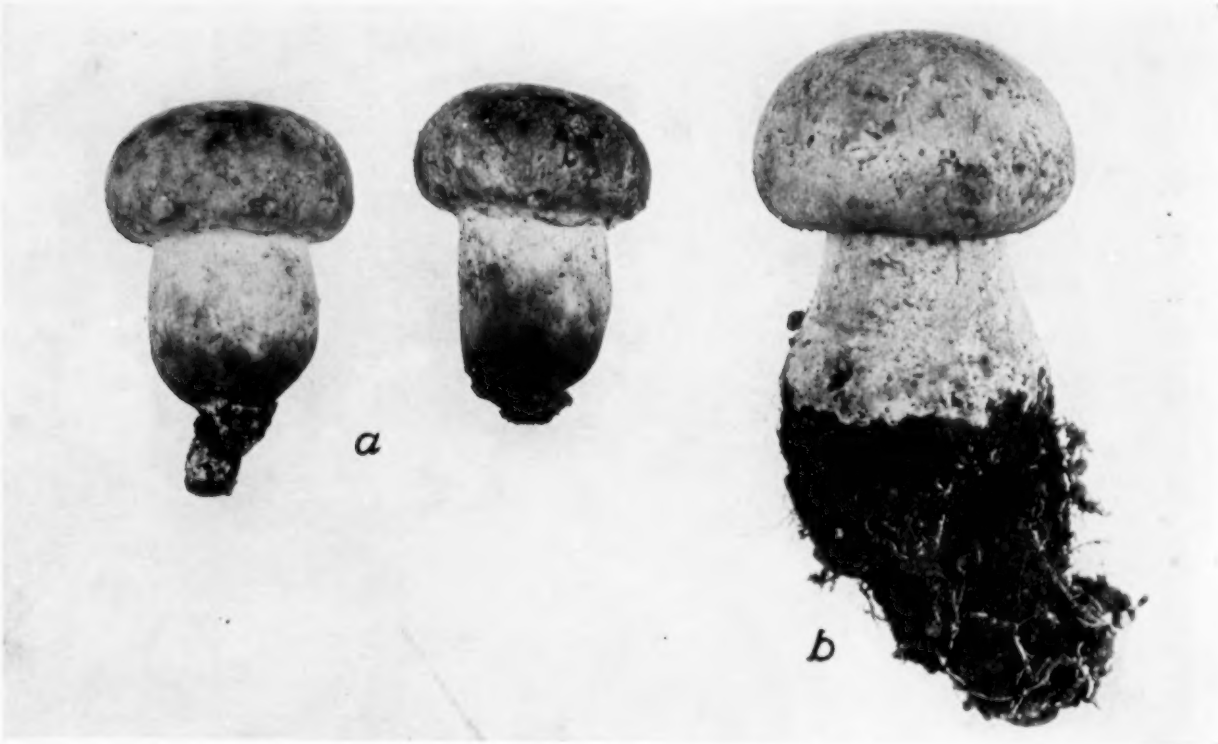
Later in the year it was again discovered causing like damage in ranges of mushroom houses at Ashtabula, Ohio, and Naperville, Illinois, and in one of the sandstone caves at St. Paul, Minnesota.

Dr. Ewing reports that he does not have any record of this mite being taken in mushroom houses and a review of the literature does not show that it has heretofore been recorded as a pest of mushrooms or found on wild fungi.

TAXONOMY.—According to Banks[1] this mite belongs to the family Eupodidae, and to the subfamily Eupodinae, which is characterized by the presence of two suckers on each side of the genital aperture, the absence of submedian sensory hairs on the cephalothorax, and indistinct segmentation of the abdomen. Mites of the genus *Linopodes* are characterized by having extremely slender legs (the front pair being much more than twice as long as the body) and hind femora somewhat thickened.

Banks describes the adult mite as being pale yellowish or reddish in color, some having white marks; one on the back in the form of a "T." The first pair of legs, which are more than twice the length of its body, are used as feelers and when the mite is disturbed it runs very rapidly.

[1]Banks, Nathan, 1915. The Acarina or mites. U. S. Dept. Agr., Report, Office of Secretary No. 108.



a. Mushrooms injured by *Linopodes antennaepes*; *b*, a normal mushroom.

Banks says, "It is common on the ground under pieces of wood, bark, etc., that have lain there some time."

NATURE OF ITS INJURY TO MUSHROOMS.—The injury resulting from the attack, of this mite on the cultivated mushroom, *Agaricus campestris*, is rather unusual. Its feeding on the "root system" causes the mushroom stalk or stipe to become very much constricted at the base. The lower half of the stipe is often discolored, the color ranging from pinkish to brown. In severe cases of damage the sporophore is held to the surface of the bed by only a few withered filaments. The injury is clearly shown in the accompanying photograph. The result of the injury from this pest under heavy infestations is a decided reduction in crop yield as the injured mushrooms do not develop to a normal marketable size. However, these small mushrooms if not too badly discolored are suitable for canning. Even though they may be disposed of for such purpose they do not bring as high a price as normal mushrooms.

A large grower in Ohio having over 325,000 square feet of mushroom bed space estimated his loss for the season from this pest to be approximately 40 per cent of the total crop or ¾ pound per square foot.

Since the habits of the mite have been under observation for only a short time, little is known as to the effect of its attacks on the mycelium. Thus far, the chief point of attack seems to be the base of the stalk after the mushroom appears above the surface of the bed. Under heavy infestations many of the mushrooms are completely covered with these mites. The fact that this species is capable of moving rapidly makes this pest all the more dangerous, since it can migrate from one bed to another much more quickly than the mushroom mite, *Tyroglyphus lintneri* (Osb.) which moves slowly.

PRELIMINARY CONTROL MEASURES.—Since the mushroom houses in Ohio where this pest was so abundant had at one time been infested with the mushroom mite, *Tyroglyphus lintneri* (Osb.), and controlled by surface steaming of the compost before it was taken into the houses the grower resorted to the same control measure. In order to ascertain the most exact and effective procedure to follow in these treatments with steam, in regard to penetration of the steam into the compost and the duration of the treatment necessary for control, the thermal death point of the mite and the temperature of the compost heap at various depths were determined. Through the courtesy of the Department of Botany of the University of Minnesota, the writer was enabled to conduct the experiments on the thermal death point of this pest in the constant-temperature chambers at that institution. From 15 to 20 adult mites were

subjected to the range of temperatures shown in Table 1, being placed in straight sided jars 2½ inches in diameter and 5½ inches tall, which were filled with composted manure and covered with fine cheese cloth.

The relative humidity in the constant-temperature chambers was maintained at about 89 per cent. Results of preliminary experiments showed that the mites congregated in the center of the compost in the jars when subjected to heat, therefore a thermometer was inserted in the center of the compost in each jar in order to obtain the temperature within the compost after a given exposure.

TABLE 1. EXPERIMENTS TO DETERMINE THE THERMAL DEATH POINT OF THE MITE *Linopodes antennaepes* IN COMPOSTED MANURE IN CONSTANT-TEMPERATURE CHAMBERS IN WHICH THE RELATIVE HUMIDITY WAS MAINTAINED AT ABOUT 89 PER CENT

Temperature of chamber		Period of exposure	Average temperature of compost on removal		Number of experiments	Results
°C.	°F.	Hour	°C.	°F.		
60	140.0	¼	53.0	127.4	3	All killed
		½	58.5	136.8	2	Do.
55	131.0	¼	48.0	118.4	3	Do.
		½	53.5	127.8	2	Do.
52	125.6	¼	47.5	117.0	2	Do.
		½	50.5	122.4	2	Do.
49	120.2	¼	42.5	108.0	2	Do.
		½	47.5	117.0	2	Do.
45	113.0	¼	40.0	104.0	1	Do.
		½	44.0	111.2	1	Do.
		¾	45.0	113.0	1	Do.
38	100.4	¼	37.5	99.0	2	A few active
		½	38.0	100.4	2	All killed

From the foregoing data it is deduced that adults of this pest can be killed when subjected to a temperature range of 40° C. to 53° C. for one-fourth hour. At 38° C. it appears necessary to expose the mites for one-half hour.

Upon comparison of these data with the results of the readings given in Table 2, made on a 300-ton manure heap at the Ohio plant, it is seen

TABLE 2. AVERAGE TEMPERATURES ON TOP, ON SIDE 1 FOOT FROM TOP, AND ON SIDE 1 FOOT FROM BOTTOM OF A 300-TON COMPOST HEAP, AT VARIOUS DEPTHS BEFORE STEAMING

Depth	Temperature on top (Average of six readings)	Temperature on side 1 foot from top (Average of three readings	Temperature on side 1 foot from bottom (Average of three readings)
	°F.	°F.	°F.
Two inches....	110	96	98
Four inches....	137	104	109
Six inches.....	158	121	125
Ten inches....	158	134	142

that the temperature below a depth of 4 inches in the manure heap is too high for the survival of the mite. Therefore it is not necessary to penetrate the compost with steam beyond that depth.

Temperature readings taken immediately after steam at 200° F. from a 2 inch outlet had passed over the surface of the compost heap showed that at a depth of 2 inches the temperature was 152° F. and at 4 inches 132° F. No live mites were found in samples of the treated compost taken at various depths.

Comparing these data with the thermal death point readings it appears as if the steam-treatment process as practiced is adequate to rid compost of these mites.

The foregoing conclusions are further substantiated by the fact that no mite infestation had developed, when last observations were made in the houses where this compost was used.

In view of the fact that very few mushroom plants are provided with the necessary equipment for surface steaming of the compost heap, other measures of control, which will be practical for the average grower, must be worked out in case the appearance of this pest becomes general.

THE LATIN SQUARE ARRANGEMENT OF EXPERIMENTAL PLATS

By F. Z. HARTZELL, *New York State Agricultural Experiment Station, Geneva, N. Y.*

ABSTRACT

Variation in infestation vitiates conclusions drawn from field tests unless the plat technique is able to compensate for such heterogeneity. The Latin Square arrangement of test plats proposed by Fisher has a number of advantages over the ordinary method of using strips across the area. The Latin Square is applicable to areas in which the variation from plat to plat occurs by approximately constant differences. It does not always compensate for heterogeneity when differences occur by chance or in approximately geometrical series. Careful studies of proposed test areas should be made to determine the type of variation present and no tests made except in those places in which a high degree of accuracy can be secured.

When an investigator makes a field experiment he usually aims to compare either the yields of certain varieties of the same crop or the effects of different treatments upon a certain variety. Since all the tests must be conducted during the same period of time, obviously, he must make the tests on different plats; so usually he selects what appears to be a very uniform area and divides this into the desired number of small blocks on which the several comparisons are to be made. If the number of plats equals the number of treatments (i.e., if there are to be no replications in treatment) he tacitly assumes that if all were treated uniformly the

yield per acre would be practically the same on every plat. The more careful experimenters have recognized the fact that the yields from a series of apparently uniform plats are not identical. For simplicity all comparisons in this paper will be yields. The application of the same ideas to insect infestation will be obvious to the reader.

Of the various arrangements proposed to overcome heterogeniety, the Latin Square of R. A. Fisher (1)[1] seems the best discovered for eliminating bias in field tests. The basic principle of this system is that there be an equal number of plats from left to right (rows) and from front to back (columns), and that each row and each column shall contain a complete series of the tests with no replications. This will be clear from a study of Chart 1 in which each plat that is to receive the same treatment is designated by a certain letter.

FORMATION AND DISCUSSION OF THE LATIN SQUARE CHESSBOARD. Fisher proposed that the selection of treatment for the plats be by lot. Suppose four treatments are to be compared. This necessitates four replications for each treatment. On a sheet of paper draw a large square, divided into 16 smaller squares, which forms a 4 x 4 chessboard. Now take four small cards of equal size and mark each with a single letter as follows: A, B, C, and D. These are placed in a bag or other opaque receptacle, thoroly mixed and a card picked out at random. Suppose the first card drawn bears the letter C, the second D, the third B, and the fourth A. Mark the upper left square of the chessboard C, the next square to the right with a D, the third square B, and the last square A. (Chart 1) Repeat the operation for the next row below. Suppose the first card is marked D and the second C. These are placed in their respective squares. A and B remain for the second row, but in order that two plats having identical treatment should not appear in the same row or column, it is necessary to mark the third square A and the fourth B. The cards are again mixed in the receptacle and a drawing made. Suppose B is on the next card. Mark the left square of the third row B. The second square must be marked A, otherwise the rule regarding replications in rows or columns would be violated. The third square can be either C or D and the drawing reveals it to be C, so the fourth square must be D. There is no choice regarding the fourth row which must be A, B, D and C respectively.

C	D	B	A
D	C	A	B
B	A	C	D
A	B	D	C

Chart 1. Plot Treatments Selected by Lot

If Chart 1 be considered a plane, it will be noted that the center of gravity of any four identical plats (e.g. the B's) is the center of the plane. In

[1]Numbers in text refer to literature cited at end of paper.

other words, the plats are balanced because the sum of their moments of inertia is zero. *If previous to treatment the variation from plat to plat is uniform, i.e., if the changes thruout the area consist of constant differences* the mean of each set of plats (the "set mean") will be identical with the mean of the sixteen plats (the "general mean"). Therefore, if after treatment, the mean of any set differs significantly from the mean of another set, it can be attributed to the treatment, not to *place variation*.

The shape of the plats makes no difference provided all are the same shape and size. This is an important consideration because in field tests usually rectangular blocks are more practical than square ones. This is especially true for spraying tests in orchards where the rectangular plat requires less turning of the team and rig for the same number of trees than does a square one.

During the past four years the writer has used the arrangement shown in Charts 2–7 (for both rectangular and square areas) instead of selecting by lot. Of course this is one of the possible chance arrangements, but it has several advantages, the chief of which are: (1) That with rectangular areas, for every treatment, two plats adjoin lengthwise two plats of every other treatment. This enables the investigator to compare treatments carefully, and to detect certain differences that might otherwise escape notice. From the viewpoint of the station worker this is very important because it assists visitors to make comparisons, since frequently experimental plats serve as demonstrations of the several treatments. This is especially true with long term tests. (2) When a number of chessboards are in use there is less danger of becoming confused in placing the applications on the correct plats than if all chessboards are different. Anyone who has attempted large scale orchard experimentation with insecticides can appreciate how easily confusion may arise.[2]

The properties of the Latin square, so far as they relate to means, will be illustrated by the charts. Those workers who desire to study the properties relating to probable errors or standard errors are referred to Fisher (1) and Student (2).

ADAPTABILITY OF THE LATIN SQUARE TO CERTAIN TYPES OF VARIATION. In Charts 2 to 5 are shown theoretical yields on 4 x 4 chessboards. The

[2]The following arrangement, lately devised by the writer, where the "border effect" is important may be preferable. However, care must be exercised in arranging the plats in order to have each treatment adjoin every other treatment lengthwise twice. It will be noted that this condition does not hold endwise for the treatments as it does in charts 2-7.

A	B	C	D
D	C	A	B
C	D	B	A
B	A	D	C

CHARTS SHOWING VARIATION WITH CONSTANT DIFFERENCES

Chart 2. Diagonal Variation

A 40	B 50	C 60	D 70	Strip means 55
B 50	D 60	A 70	C 80	65
C 60	A 70	D 80	B 90	75
D 70	C 80	B 90	A 100	85
Strip means	55	65	75	85	Gen. mean 70

	Set means
A's = 40+70+70+100 =	70
B's = 50+50+90+ 90 =	70
C's = 60+80+60+ 80 =	70
D's = 70+60+80+ 70 =	70

Chart 3. Peaked and Skew Variation

A 70	B 80	C 70	D 60	Strip means 70
B 80	D 90	A 80	C 70	80
C 70	A 80	D 70	B 60	70
D 60	C 70	B 60	A 50	60
Strip means	70	80	70	60	Gen. mean 70

	Set means
A's = 70+80+80+50 =	70
B's = 80+80+60+60 =	70
C's = 70+70+70+70 =	70
D's = 60+90+70+60 =	70

Chart 4. Asymetrical Inclined Trough Variation

A 100	B 90	C 80	D 90	Strip means 90
B 90	D 80	A 70	C 80	80
C 80	A 70	D 60	B 70	70
D 70	C 60	B 50	A 60	60
Strip means	85	75	65	75	Gen. mean 75

	Set means
A's = 100+70+70+60 =	75
B's = 90+90+70+50 =	75
C's = 80+80+80+60 =	75
D's = 90+80+60+70 =	75

Chart 5. Asymetrical Concave Variation

A 90	B 80	C 70	D 80	Strip means 80
B 80	D 70	A 60	C 70	70
C 70	A 60	D 50	B 60	60
D 80	C 70	B 60	A 70	70
Strip means	80	70	60	70	Gen. mean 70

	Set means
A's = 90+60+60+70 =	70
B's = 80+80+60+60 =	70
C's = 70+70+70+70 =	70
D's = 80+70+50+80 =	70

areas represent conditions existing when all plats are planted to the same variety and are under uniform treatment, the object being to show which types of variation are suitable for field tests either with different varieties or the same variety under different treatments. For simplicity of reference, let each chart be considered a map with the top representing north.

A simple arrangement of plats is in strips. With this method, obviously the strip yields would not be identical unless there were no variations or unless the variations were strictly parallel with the strips. In Charts 2–7 each strip contains four plats. The mean of each set of plats ("strip mean") can be compared with the general mean of the plats, but most important is the ability to determine the direction of variation in yield across the area. The strip means for rows and columns will be given in all the charts for comparison with each other and with the general mean. Also, the set means can be compared with the general mean in each chart.

The criterion of accuracy is the amount of difference between parallel strip means, also between the general mean and the set means. Obviously, the smaller these differences, the more accurate is the arrangement.

An examination of Charts 2–5 shows that so long as the variation from plat to plat occurs by equal differences, the Latin Square will cause the set means to be identical with the general mean regardless of whether the variations occur under the following types: Diagonal, peaked and skew, asymetrical trough or asymetrical concave. However, in none of these cases are the parallel strip means identical regardless of whether the strips run north and south or east and west. For this reason none of these types would be suitable for an experiment in which the strip method is used. Nevertheless, all would be suitable for field tests if the plats followed the Latin Square arrangement.

It will readily be noted that in field tests these types of variation are more probable than variations parallel to the strips, therefore if the Latin Square can be used, more opportunity will be offered for making field tests. In fact, if the strip method is used, in many instances either no tests could be made or the experimenter must use a faulty technique. Entomological examples of the four types of variation in Charts 2 to 5 are as follows:

Diagonal, grape-vine fleabeetle, grape root-worm, grape leafhopper, codling moth, and rose chafer.

Peaked and skew, grape root-worm and codling moth.

Asymetrical Inclined Trough, grape leafhopper, pear psylla, and rosy aphis.

Asymetrical Concave, pear psylla, grape leafhopper, and cutworms.

Chart 6. Hyperbolic Sheet Variation

A 100	B 100	C 100	D 100	Strip means 100
B 69	D 69	A 69	C 69	69
C 59	A 59	D 59	B 59	59
D 55	C 55	B 55	A 55	55
Strip means	70.8	70.8	70.8	70.8	70.8

Set means

A's, B's, C's and D's =
100+69+59+55 = 70.8

Chart 7. Diagonal Hyperbolic Variation

A 100	B 69	C 59	D 55	Strip means 70.8
B 69	D 59	A 55	C 54	59.3
C 59	A 55	D 54	B 53	55.3
D 55	C 54	B 53	A 53	53.8
Strip means	70.8	59.3	55.3	53.8	Gen. mean 59.8

Set means

A's = 100+55+55+53 = 65.8
B's = 69+69+53+53 = 61.0
C's = 59+54+59+54 = 56.5
D's = 55+59+54+55 = 55.8

TYPES OF VARIATION IN WHICH THE LATIN SQUARE GIVES SMALL GAIN IN ACCURACY. In Charts 6 and 7 are shown types of variation where the differences between plats in one or more directions are in approximately geometrical progression.

In the hyperbolic sheet type the variation extends parallel with the strips running north and south. The means of the north and south strips are identical, while the means of the east and west strips are not. It will be noted that in this type there is no advantage in using the Latin Square arrangement, at least so far as the means are concerned. In the Diagonal Hyperbolic type neither series of strip means are identical, and furthermore, the set means are not identical with the general mean. Altho there is a slight increase in accuracy by the use of the Latin Square, the discrepancies are too large to consider this type as suitable for field tests.

Entomologically, the finest examples of these two types in nature observed by the writer are furnished by the grape-berry moth. In western New York these are the usual forms of distribution of this insect.

CONCLUSIONS. The Latin Square or chessboard arrangement of field plats offers a method that generally greatly improves the accuracy of the test over the strip arrangement provided the plat differences are approximately equal. By employing the Latin Square, frequently areas can be

used for field tests that would be very inaccurate by the strip method. Where plat differences occur more or less in geometrical proportion, the Latin Square adds practically nothing in accuracy over the strip arrangement. Such areas are suitable for field tests only when the variation is strictly parallel with the strips (Hyperbolic sheet). It follows that the investigator must not look upon the Latin Square as a fetish that will drive away all the evil spirits coupled with variation in field tests. He should first make careful observations supported by as much numerical data as practicable before laying out a series of field tests, using the Latin Square arrangement, if practicable, with types of variation where accuracy is to be gained and avoiding the use of areas where inaccuracy is bound to affect the results regardless of the plat arrangement.

LITERATURE CITED

1. FISHER, R. A. Statistical Methods for Research Workers, 2d Ed. Edinburgh. 1928.
2. "STUDENT." Mathematics and Agronomy, J. Am. Soc. Agron. 18:703–19. 1926.

PETROLEUM OIL SUMMER SPRAYS FOR PINE LEAF SCALE CONTROL (FAMILY COCCIDAE—ORDER HOMOPTERA)

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ABSTRACT

Petroleum oils of the following types were tested in the field during the summer of 1928 for their toxicity to the White Pine Scale, *Chionaspis pinifoliae* (Fitch):—(1) Lubricating oil, (2) Miscible oil, (3) Three grades of highly refined "white oil." The tolerance of the various coniferous foliages to these oils was also determined. Little difference was noticed in the toxicity of the oils (when compared at strengths sufficient for control). An oil concentration of 2.5 per cent was sufficient to give commercial control (90–100%). Highly refined "white oils" (Baume 36.6°–35.4°, Saybolt viscosity 45–85 sec/100° F.) were the only oils which could be applied (at a concentration sufficient for control) without subsequent foliage injury. The conifers tested varied in their susceptibility to oil spray injury in the following order: (1) White Spruce (most susceptible), (2) White Pine, (3) Red Pine and Scotch Pine (least susceptible).

The bloom normally present on conifers disappears when an oil spray is applied. It reappears within 5–10 weeks, depending on weather conditions and the volatility of the oil applied.

The pine leaf scale [*Chionaspis pinifoliae* (Fitch)][1] is an important nursery pest in the North Central States. Since the parasites of this insect

[1]The author wishes to acknowledge with thanks the identification of the insect by Dr. Harold Morrison, Bureau of Entomology, Washington, D. C.

do not appear to be controlling it,[2] there is need for an efficient insecticide which will not only control the scale but will cause no damage to the pine foliage.

Petroleum oil has hitherto been considered one of the most effective insecticides for scale insects. Unrefined lubricating oils, however, are unsafe to apply to trees in foliage, and miscible oils (petroleum oils with a soluble emulsifying agent) appear to be variable in their action. The highly refined "white oils" have recently been found safe to apply to several types of deciduous foliages.[3,4] The "white oils" are produced by treating the crude oil repeatedly with concentrated sulphuric acid.

In these experiments, lubricating oil, miscible oil and highly refined "white oils" have been tested to ascertain their toxicity to the scale and their toleration by coniferous foliage. The experiments are divided into two series:

(1) Toxicity of the oils at various concentrations to the white pine scale.

(2) Tolerance of the various species of conifers for the several types of petroleum oils.

All the sprays were applied during the summer of 1928. Spraying began on May 26 and was continued at intervals until August 8, 1928.

MATERIAL AND PROCEDURE OF THE EXPERIMENTS. A heavily infested group of White and Red Pines 15–20 years old was used for the toxicity experiments. A group of uninfested nursery seedlings of White Pine, Scotch Pine, and White Spruce, (3–5 years old) as well as a group of mature White Spruce and Red Pine, was utilized for the tolerance experiments.

Table 1 gives the specifications of the oils and emulsions of these oils which were tested in the experiments. In the case of commercial products, the emulsions were broken and the specifications determined on the oil base. Viscosity was measured by the Saybolt Universal Viscosimeter at 100° F. The per cent of unsaturateds present was measured by the loss to 38 normal fuming sulphuric acid.[5]

TOXICITY EXPERIMENTS. The sprays were applied at a pressure of approximately 125 pounds per square inch, and the trees were thoroughly

[2]Counts made on 25 thousand scales collected at Ames, Iowa, showed a parasitization of 1.4 per cent. The majority of this 1.4 per cent were parasitized by the hymenopterous parasite, *Perissopterous pulchellus* Howard.

[3](1928) Harman, S. W. "Midsummer Sprays for the Peach Cottony Scale." New York State Agr. Exp. Sta. (Geneva) Bull. 552.

[4](1928) deOng, E. R. "Progress Report on the Use of Petroleum Oil as an Insecticidal Spray." Jour. of Econ. Ent. 21:No. 4, pp. 525–529.

[5]Journal of Official Agricultural Chemists, Washington, 10, No. 1, p. 30 (1927).

wet in all cases. Counts were made of the live and dead scales one month after treatment. A number of infested needles were taken from scattering points over the tree in order to secure a representative sample and tallys were made from these. One thousand or more scales were counted in the majority of the experiments. For the determination of the efficiency of the application, account was taken of the percentage of living scales present in the control trees at the time the count was made. Abbott's method[6] for computing the efficiency of insecticides was used. This is essentially as follows:

Let x = per cent of living on the control trees,
and y = per cent of living on the treated trees.

Then $\frac{x-y}{x}(100)$ = efficiency of the insecticide.

TABLE 1. SPECIFICATIONS OF PETROLEUM OILS AND EMULSIONS

	Specifications of Emulsions			Specifications of Oil Base		
Oil	Market Type	Emulsifying Agent	Oil Strength of Stock	Viscosity Saybolt/ 100° F.	Baume Reading at 60° F.	Unsulfonated Residue
WHITE OILS						
(1) Light	Commercial	Non-soap	65%	45 seconds	36.6°	98–100%
(2) Medium	Commercial	Non-soap	65%	85 "	35.4°	98–100%
(3) Heavy	Commercial	Non-soap	65%	111 "	31.8°	90– 93%
LUBRICATING OIL	Home-made	Potash fish oil soap	65%	237 "	27.4°	Low
MISCIBLE OIL	Commercial	Oil-soluble soap	Approx. 90%			

The first applications were made at 2.5 and 5 per cent total oil concentrations. In later experiments the strength was lowered to one and two per cent.

Table 2 gives the results of the toxicity experiments. The sprays were not all applied on the same date so that they are not strictly comparable. The results can be considered indicative, however, of the toxicity of the various types of oil.

The majority of the sprays of 2.5 per cent oil strength gave complete control (95 per cent or over). Two per cent strength of the heavier oils appeared to be sufficient. There seems to be little difference in the toxicity of the white oils, lubricating oils, and miscible oils used in these experiments. However, oil sprays at strengths below two per cent total oil vary considerably in their final kill. The heavier oils (i.e. with greater specific gravity) gave the greater kill in this case. One spray applied on

[6](1925) Abbott, W. S. Method for Computing the Effectiveness of an Insecticide. Jour. of Econ. Ent., Vol. 18, No. 2. 265–267.

July 3rd, was followed shortly after the application by a heavy rainstorm. This may account for the low kills produced by sprays applied on that date.

TABLE 2. TOXICITY OF VARIOUS PETROLEUM OILS USED AGAINST THE PINE LEAF SCALE, AMES, IOWA (1928)

Oil	Concentration	Date	Total number of scales counted	Per cent Kill (as computed by Abbott's Method)
Light White Oil (Say. Vis. 45/100° F.)	1%	7–3	1050	31%
	2%	7–3	1025	27%
	2.5%	5–26	1226	88%
	2.5%	5–26	820	99%
	5%	5–26	1040	100%
Medium White Oil (Say. Vis. 85/100° F.)	1%	7–5	930	49%
	2%	7–5	1094	97%
	2.5%	5–26	1086	99%
	2.5%	5–26	1099	97%
	5%	5–26	1032	100%
Heavy White Oil (Say Vis. 111/100° F.)	1%	7–3	952	45%
	2%	7–3	1106	100%
	2%	8–6	1286	100%
	2.5%	6–8	1251	100%
Miscible Oil	2%	7–3	1058	63%
	2.5%	5–26	1021	93%
	2.5%	5–26	833	100%
	5%	5–26	1053	100%
Lubricating Oil (Say. Vis. 237/100° F.) *Boiled Emulsion*	1%	7–5	1021	77%
	2%	7–5	1018	100%
	2.5%	6–2	1120	100%
	5%	6–2	1102	100%
Cresylated Emulsion	2.5%	6–2	1643	98%
				Actual Per Cent Dead
Control Counts	—	7–12	715	18.8%
	—	7–18	1080	29.6%
	—	8–6	1223	21.2%

TOLERANCE EXPERIMENTS. In the tolerance experiments, the oil concentrations of the sprays tested were varied from one to four per cent. One set of trees was given only one application; each spray being applied to an individual of each of the four types of conifers. Another set of trees was given two applications of a two per cent spray with an interval of one month between sprays. This last experiment was designed to test for any accumulative effect.

The condition of the tree was followed by periodical examinations until June 1929. The condition noted at that time was considered as the final criterion of the spray. Injury to the tree was judged by the appearance of the 1928 growth: whether the needles had dried up and dropped off or whether they were in a normal healthy condition.

It was found that there was a difference among the various species of conifers in their susceptibility to oil spray injury. They varied in the following order:

(1) White Spruce (most susceptible), (2) White Pine, (3) Scotch Pine and Red Pine (least susceptible).

The results of the experiments in which two applications were made indicate that few oils can be applied twice without subsequent foliage injury. Only the light "white oils" caused no injury. Even though an oil was chemically non-toxic to the foliage, the long physical contact with the resulting interference in the action of respiration and transpiration would certainly cause damage.

Lubricating oils (at 2 per cent oil strength) consistently caused damage from a single application. Miscible oil was inconsistent in its results, at one time causing no injury, at another producing severe damage. Heavy "white oil" (31.8° B., Saybolt viscosity 111 sec. at 100° F.) also caused considerable injury. That this oil was not as highly refined as the other white oils is shown by the lower amount of unsulfonated residue. The light and medium "white oils" caused no foliage injury at two per cent strength. Even at the higher oil strength (4 per cent) only two trees out of the thirteen treated were injured to any perceptible extent. These results indicate that only the light "white oils" (varying up to 85 seconds in Saybolt viscosity at 100° F. and as low as 35.4° Baume) are safe to apply to conifers at a strength which will control the scale.

Most of the foliage injury caused by the various oil sprays did not appear until the following spring. At that time, the growth of the previous year (that is, the needles which were developing at the time the spray was applied) was partially or entirely shed. This growth was replaced during the following summer so that by the next fall, there was no evidence of foliage injury. This type of injury was especially noticeable on Spruce. Other investigators[7] have observed similar effects following the application of oil sprays to spruce.

An abnormal shedding of foliage such as this would seem to have a very serious effect on the growth and health of a spruce tree. Especially

[7](1926) Herrick, G. W. and T. Tanaka. "The Spruce Gall-Aphid." Cornell University Agricultural Experiment Station Bull. 454, p. 15.

would this be the case with young nursery seedlings which are already in a weakened condition as a result of transplantation.

When an oil spray is applied to a conifer, the bloom, which adds so much to its appearance, disappears. It returns within five or ten weeks, depending on the weather conditions and the volatility of the oil.

Thanks are due to both Dr. C. J. Drake and Dr. C. H. Richardson for suggestions and criticisms on this problem.

PHYSICAL AND CHEMICAL PROPERTIES OF COMMERCIAL ARSENICAL INSECTICIDES II. MAGNESIUM ARSENATE

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Abstract

Commercial magnesium arsenate insecticides are prepared by treating magnesium hydroxide suspended in water, or a solution of a magnesium salt, with arsenic acid or an alkali arsenate. The di or trimagnesium arsenate is formed, depending upon the proportion present of the reacting compounds. The reaction products are then heated in an autoclave to a temperature of 165–175° C. under pressure for several hours in order to reduce the water soluble arsenic content to a low value. The product is then filtered, dried and ground to a fine powder.

There are two grades of this product on the market, and a typical chemical and physical analysis of each is given. They both contain a crystalline material of which certain of the optical properties agree with those of the basic arsenate $Mg_3(AsO_4)_2.MgO.YH_2O$ mentioned in the patents. A short review of the published entomological tests with this material is included.

The purpose of this paper is to outline the commercial methods of preparing magnesium arsenate; to give the composition of commercial magnesium arsenate insecticides now on the market, and to refer briefly to the experimental work in pest control carried out by entomologists with these products.

Historical. The use of magnesium arsenate as an insecticide is comparatively recent, although the first patent application (1) for its manufacture was filed in 1918. Since then other patents (2, 3, 4) have been issued for the manufacture of the insecticide. The early manufactured product was considered unsafe for spraying upon foliage, and was little used, but recently an improved product has been coming into more general use. Considerable effort has been made to prepare the insecticide in a form sufficiently safe for tree spraying.

Manufacture of Commercial Magnesium Arsenate Insecticides. The first patented method of making magnesium arsenate as an insecticide is carried out by bringing together magnesium hydroxide (or some magnesium salt) suspended in water and a solution of arsenic acid

or sodium arsenate. The reactions that may take place according to the proportions of the combining compounds are:

(1) $Mg(OH)_2+H_3AsO_4=MgHAsO_4+2H_2O$

(2) $3\ Mg(OH)_2+2H_3AsO_4=Mg_3(AsO_4)_2+6H_2O$

The di-magnesium orthoarsenate is formed in reaction (1), and the tri-magnesium orthoarsenate is formed in reaction (2).

An improved method of manufacture also has been patented (3). The product obtained in the former method of manufacture had a relatively high water soluble arsenic content. The improved method gives a very low water soluble arsenic figure. The process is carried out by running arsenic acid into magnesium hydroxide suspended in water until the desired arsenic content is obtained, then the mixture is heated to 165–175° C. under pressure in an autoclave for several hours. The material, when removed from the autoclave, is allowed to settle, then filtered, dried and ground.

According to patent specifications, the magnesium arsenate is present in one or all of three distinct crystalline forms. This crystalline material may or may not be mixed with an excess of magnesium hydroxide. Of the three forms that have been identified, the one occurs as exceedingly small, rather lens-shaped crystals, having parallel extinction and a negative principal zone, the indices of refraction being $n\alpha=1.64$ and $n\gamma=1.66$. The probable formula for this compound is $MgHAsO_4xH_2O$, in which the value for (x) has not been definitely determined.

A second form occurs either as long, needle-shaped crystals; as elongated, pointed-end crystals; or as short, flat prisms, having parallel extinction and a positive principal zone, the indices of refraction being $n\alpha=1.58$ and $n\gamma=1.605$. The probable formula for this form is $Mg_3(AsO_4)_2.MgO.YH_2O$, in which the value for (Y) has not yet been determined.

The third form is probably represented by the formula $Mg_3(AsO_4)_2.2MgO.2H_2O$. This form occurs as exceedingly small lens-shaped crystals, having parallel extinction and a positive principal zone, the indices of refraction being $n\alpha=1.566$ and $n\gamma=1.575$.

ANALYTICAL DATA. Two samples of commercial magnesium arsenate of recent manufacture were analyzed. The labels on the samples were as follows:

Sample No. 1

Active Ingredient as Tri-magnesium Arsenate [$Mg_3(AsO_4)_2$] not less than 48.80 per cent

Inert Ingredient not more than 51.20 per cent

Total Arsenic as Arsenic Pentoxide (As_2O_5) not less than 32.00 per cent.

Water Soluble Arsenic as Arsenic Pentoxide (As_2O_5) not more than 0.35 per cent.

Sample No. 2

Active Ingredient as Tri-magnesium Arsenate [$Mg_3(AsO_4)_2$] not less than 61.00 per cent

Inert Ingredient not more than 39.00 per cent

Total Arsenic as Arsenic Pentoxide (As_2O_5) not less than 40.00 per cent.

Water Soluble Arsenic as Arsenic Pentoxide (As_2O_5) not more than 0.35 per cent.

The analytical work was carried out according to the A.O.A.C. Methods (Second Edition, Revised to July 1, 1924), and "Standard Methods of Chemical Analysis," by Scott (Second Edition, Revised 1917).

The cubic-inches-per-pound were determined by passing the insecticide through a 30-mesh sieve held about an inch above a vessel of known volume and weight. The material was carefully leveled off and the vessel weighed. From the weight of the contained material and the volume of the vessel the cubic inches occupied by a pound of magnesium arsenate is readily calculated.

The pH value was determined by means of the LaMotte comparator, using the LaMotte color standards. Ten grams of the arsenate were mixed with 500 cc. of distilled water at room temperature (approximately 25° C.) and allowed to stand for two hours, with frequent shaking; then samples were filtered off, and the pH value determined. The pH of the distilled water used was 6.6.

The suspensibility test was made by shaking 1.2 gram samples of the arsenate in 500 cc. of distilled water at 25° C. This represented 2 pounds arsenate to 100 gallons of water. When thoroughly mixed the cylinder was allowed to stand at 25° C. for a definite time, and the top half (250 cc.) then siphoned off into a weighed beaker. The beaker was placed on the steam bath and its contents evaporated to dryness, then dried and weighed. The percentage of material held in suspension is found by multiplying the weight of the salts found on evaporation by 100 and dividing by 0.6. The data obtained by analysis are tabulated in Table 1.

The samples were submitted to microscopical examinations (5). Both samples were composed largely of small needles which had the following optical properties; the extinction is parallel and the sign of elongation is plus. The indices of refraction are $n\alpha = 1.578$ and $n\gamma = 1.60$, both $\pm .003$. These values are practically the same as those given by Barstow (3) for the basic compound $Mg_3(AsO_4)_2.MgO.YH_2O$. The chemical data reported here are insufficient to substantiate the presence

of this compound, although they do show a proportion of magnesium oxide more than sufficient to agree with it.

TABLE 1. ANALYSES OF COMMERCIAL MAGNESIUM ARSENATES

	Sample No. 1 Per cent	Sample No. 2 Per cent
Moisture	0.8	0.7
Total Arsenic Pentoxide (As_2O_5)	32.6	41.0
Water Soluble Arsenic Pentoxide (As_2O_5)	0.04	0.1
Water Soluble Salts at 25° C	2.5	2.6
Total Arsenious Oxide (As_2O_3)	0.1	0.2
Insoluble in Hydrochloric Acid Silicon Dioxide (SiO_2)	0.6	0.7
Aliminum Oxide, Al_2O_3; Ferric Oxide Fe_2O_3	0.3	0.8
Calcium Oxide (CaO)	1.4	1.5
Total Magnesium Oxide (MgO)	47.9	44.2
Cubic inches per pound	145	113
pH value of 2% suspension	9.8	9.8
Suspensibility:		
1.2 g./500 cc. H_2O at 25° C.		
2 min	78%	76%
5 "	33%	47%
10 "	16%	19%
30 "	9%	12%
60 "	8%	9%

APPLICATION AS INSECTICIDES. According to the earliest recorded account found, magnesium arsenate was first used as an insecticide in 1919, when it was sprayed on tree foliage, resulting in severe injury. Patten and O'Meara (6) found that magnesium arsenate was soluble in water containing carbon dioxide to the extent of 41.7 per cent of the total arsenic content.

Patten (7) in 1921 made a study of the solubility of calcium and magnesium arsenates in carbon dioxide and its relation to foliage injury.

Cook and McIndoo (8) tested several new arsenicals, namely, the arsenates of barium, copper and barium, magnesium, and aluminum. None showed as high toxicity as acid lead arsenate. They concluded that chemical analysis does not give sufficient data to judge satisfactorily its insecticidal properties.

Marcovitch (9) in 1924 recommended a spray of magnesium arsenate (2 pounds to 100 gallons of water) to be applied to the lower surface of the leaves of the bean plant in the control of the Mexican bean beetle.

Miller (10) describes the use of magnesium arsenate dust (1 pint magnesium arsenate to 5 pints hydrated lime) in the control of the Mexican bean beetle. The results in regard to yield of beans and control of beetles were equal to those obtained with lead or calcium arsenates. Slight injury was reported as resulting from the use of calcium, magnesium, and lead arsenate.

The Report (11) of the Entomologist of the United States Department of Agriculture for 1925 states that calcium and magnesium arsenate at

high dilution are more effective than sodium fluosilicate against the Mexican bean beetle.

Leach (12) experimented with the basic and acid arsenates of lead as soil insecticides. He found that certain arsenates are toxic to the larvae of the Japanese beetle (*Popillia japonica* Newman), but that the basic arsenate of lead, and the arsenates of magnesium and iron (scorodite) are non-toxic. The arsenates non-toxic to the larvae proved to be non-toxic to the plants.

Guyton and Knull (13) recommended the use of magnesium arsenate as dust or as a spray in the control of the Mexican bean beetle. The water soluble arsenic content should not be in excess of 0.5 per cent calculated as arsenic pentoxide (As_2O_5).

Melander and Spuler (14) used magnesium arsenate in a poison bait against the strawberry root weevil. They found that it was the most effective of the poisons tried and that it gave good control.

Eddy and McAllister (15) found that magnesium arsenate caused less injury to bean plants when diluted with four parts hydrated lime and that it was as toxic to the Mexican bean beetle as any material tried. The compounds tested were: The fluosilicates of calcium, barium and sodium; and the arsenates of calcium, magnesium, lead and zinc.

Smith (16) used magnesium arsenate in direct application for the control of black vine weevils.

Cecil (17) recommends the use of magnesium arsenate as dust or as a spray in the control of the Mexican bean beetle.

Urbahns (18) says that magnesium arsenate has been considered unsafe for spraying upon foliage, but that it is coming into more general use in connection with poison bait for the control of strawberry root weevils, and possibly other forms, such as the vegetable weevils.

Downes (19) experimented with a poisoned apple-waste bait against the strawberry root weevil. He used sodium fluosilicate, calcium arsenate and magnesium arsenate: All gave good results.

Mote and Wilcox (20) used a poisoned bean bait, which gave 100 per cent mortality in 12–23 hours in laboratory tests against *O. ovatus* and *O. rugifrons*.

Snapp (21) carried out a series of experiments with a number of insecticides on peach trees to determine their effectiveness against the plum curculio (*Conotrachelus neunphar*). Magnesium arsenate did not give as good results as lead arsenate.

Howard (22) says that calcium or magnesium arsenate with lime is superior to sodium fluosilicate for the control of the Mexican Bean beetle.

Alden and Yeomans (23) experimented with the new arsenical sprays against the codling moth in Georgia.

All gave poor results when compared to lead arsenate, and most of them injured the foliage severely. Magnesium arsenate gave the best results of the new sprays.

In the Report (24) of the Committee of Economic Entomologists to formulate plans for investigating the codling moth, a summary of four laboratory and twelve field tests shows that magnesium arsenate is about one-half as effective as lead arsenate in controlling the codling moth. Severe injury to the foliage in several cases was recorded.

Caffrey and Huber (25) say that the application of insecticides, including magnesium arsenate, invariably has proved ineffectual in protecting growing corn from injury by the European corn borer in all experiments conducted up to the present time.

References

1. Methods of Making Magnesium Arsenate. U. S. Patent No. 1,344,018, By Edwin O. Barstow. Filed Sept. 16, 1918. Patented June 22, 1920.
2. Insecticide and Method of Making Same. U. S. Patent No. 1,420,978. By Herbert H. Dow. Filed Jan. 27, 1919. Patented June 27, 1922.
3. Insecticide and Method of Making Same. By Edwin O. Barstow. U. S. Patent No. 1,466,983. Filed Sept. 1, 1920. Patented Sept. 4, 1923.
4. Improvements Relating to the Manufacture of Fungicidal, Insecticidal and Like Media. By Wilfred Carpmael. British Patent No. 251,330. Application Jan. 27, 1925. No. 2435/25; Accepted April 27, 1926.
5. The microscopical examination was carried out by Mr. George L. Keenan of the Food, Drug and Insecticide Administration, Washington, D. C.
6. The Probable Cause of Injury Reported from the Use of Calcium and Magnesium Arsenates. By. A. J. Patten and P. O'Meara, Michigan Agr. Expr. Sta. Quart. Bull., Vol. 2, No. 2, pp. 83–84 (1919).
7. The Solubility of Calcium and Magnesium Arsenates in CO_2 and its Relation to Foliage Injury. By A. J. Patten, J. Assoc. Official Agr. Chem. *4*, pp. 404–406 (1921); C. A. *14*. p. 446 (1921).
8. Chemical, Physical and Insecticidal Properties of Arsenicals. By F. C. Cook and N. E. McIndoo, U. S. Dept. Agr. Bull. 1147, pp. 1–55 (1923).
9. New Insecticides for the Mexican Bean Beetle and Other Insects. By S. Marcovitch, Tenn. Agr. Exp. Sta. Bull. 131 (1924), R. A. E. Ser. A. *13*, 118 (1925).
10. The Mexican Bean Beetle. By A. E. Miller, Ohio Agr. Exp. Sta. Monthly Bull. 9, No. 11–12, pp. 197–204 (Nov. Dec. 1924) R. A. E. Ser. A. *13*, 328 (1925).
11. Report (1923–1924) of Entomologist. U. S. Dept. Agr. pp. *35* (1925).
12. Experiments with Certain Arsenates as Soil Insecticides. By B. R. Leach, J. Agr. Res. *33*, 1–8 (1926) R. A. E. Ser. *14*, 526–527 (1926).
13. Mexican Bean Beetle in Pennsylvania. By T. L. Guyton and J. N. Knull, Penn. Dept. Agric. Gen. Bull. 417, (1925) R. A. E. Ser. A, *14*, 352 (1926).
14. Poisoned Baits for Strawberry Root Weevils. By A. L. Melander and A. Spuler, Wash. Agr. Exp. Sta. Bull. *199*, 22 (1929) R. A. E. Ser. A. *14*, 271 (1926).
15. The Mexican Bean Beetle. By C. O. Eddy and L. C. McAlister, Jr. So. Carolina Agr. Exp. Sta. Bull. 236, pp. 3–38 (1926) (Ann. Report 1926–1927).

16. The Black Vine Weevil as a Pest in Greenhouses and Nurseries. By F. F. Smith, J. Econ. Ent. *20*, 127–131 (1927).
17. The Mexican Bean Beetle. By Rodney Cecil, N. Y. Agr. Exp. Sta. Circular 96 (1927).
18. Commercial Insecticides and Some of their Uses. By T. D. Urbahns, California Dept. Agr. Monthly Bull. 16, No. 10, pp. 525–536 (Oct. 1927).
19. Recent Developments in Strawberry Root Weevil Control. By W. Downes, J. Econ. Ent. *20*, 695 (1927).
20. The Strawberry Root Weevils and Their Control in Oregon. By D. C. Mote and J. Wilcox, Ore. Agr. Exp. Sta. Circular No. 79 (Feb. 1927).
21. A Preliminary Report of Toxic Value of Fluosilicates and Arsenicals as Tested on the Plum Curculio. By O. I. Snapp, J. Econ. Ent. *21*, 175–178 (1928).
22. Some Notes on the Mexican Bean Beetle Problem. By N. F. Howard, J. Econ. Ent. *21*, 178–182 (1928) C. A. *22*, 2024 (1928).
23. Codling Moth Control in Georgia Apple Orchards. By C. H. Alden and M. S. Yeomans, J. Econ. Ent. *21*, 319–324 (1928).
24. Report of Committee of Economic Entomologists to Formulate Plans for Investigations of Codling Moth from Biologic and Control Standpoints, J. Econ. Ent. *21*, 36 (1928).
25. The Fundamental Phases of European Corn Borer Research. By D. J. Caffrey, and L. L. Huber, J. Econ. Ent. *21*, 104 (1928).

STUDIES IN APPLE MAGGOT CONTROL IN THE HUDSON VALLEY

By F. G. MUNDINGER, *Hudson Valley Fruit Investigations*

ABSTRACT

The timing of poison applications for apple maggot, *Trypeta pomonella*, is best determined by the use of large emergence cages under nearly natural conditions. Arsenate of lead, 2½ pounds to 100 gallons, applied as the flies are beginning to increase in numbers and a second application about ten days after the first give a large measure of protection. It is well to observe early varieties and protect them first. The maintenance of a poison cover, spray or dust, during the pre-oviposition period seems to be a very promising safeguard.

In 1925 many orchardists thru-out the Hudson Valley sustained severe financial losses due to the apple maggot and in succeeding years a number of orchards not carefully guarded were badly infested by the pest. During the last four years a part of each season was devoted to the study of the maggot. Data regarding its habits have been secured and various materials were used experimentally in an attempt to develop control measures.

It has long been known that the apple maggot passes the winter in the soil as a puparium and that it makes its appearance during the summer months as the adult or apple maggot fly. Little information on the time and manner of appearance of the flies was available for this region so a

study of emergence was the first step taken in the work. In order to proceed under conditions as nearly natural as possible, large trap cages 10ft. by 4 ft. by 3 ft., made of light wooden strips and cheese cloth were placed thru-out the orchards under trees which had shown heavy infestation the previous year. Every cage covered forty square feet of soil and was made as fly-tight as possible. One end was so arranged that entrance was easily gained for observation and collection of flies.

About fifteen such cages were used each year on new locations. Several other cages were left on their original sites to determine the numbers of two-year flies emerging. A few cages were also established each year over early infested apples to study the possibilities of a double brood in one season. Observations of all cages were made daily.

Figure 67 shows in graphic form the emergences for the several years, 1926, 1927, 1928 and 1929. It will be noted that the period of maximum emergence varied somewhat in duration and in the time of occurrence

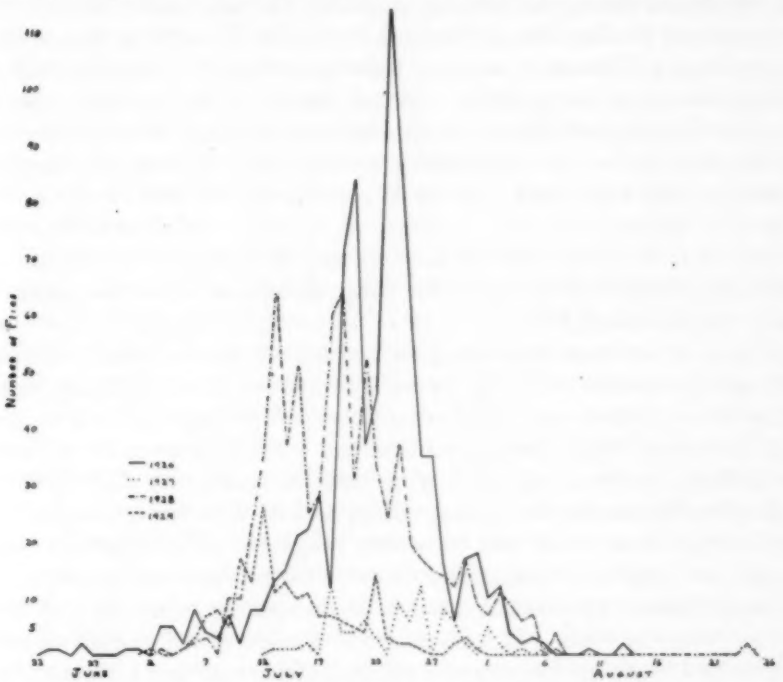

FIG. 67.—Emergence records of apple maggot flies.

during the four years, which shows that the calendar dates cannot be depended upon for timing protective applications. The yields of the cages varied considerably, some producing a few flies and others, as

many as forty-four per day. One cage, blown over during a rain storm and reset, yielded twenty-nine flies in one hour.

Temperature may play a role in emergence, for in the above instances the periods of maximum emergence followed the first series of warm days after July 1st. It seems reasonable to believe that soil moisture may be a factor of some importance in this respect since the greatly reduced emergences of 1927 and 1929 paralleled corresponding dry months. More flies were obtained from cages on uncultivated soil than from cages over areas where the soil had been disturbed. Early varieties showed a somewhat earlier maximum emergence period than late varieties. In 1927 only fifteen flies were taken from fifteen cages left on original sites for two seasons, indicating that the great majority of flies have a life cycle of one year in this area. The probability of two broods in one season also appears very slight.

Considering that there are indications of varietal differences affecting the maximum emergence periods and, that the progressive manner of emergence of the flies of each tree is so similar in character to that of the aggregate of all the trees, one may infer that there is probably a rather definite duration for pupation. Hence, seeded cages supplied with a mixture of apple varieties or containing fruits gathered at random with no regard as to the time of dropping, may or may not show an accurate picture of the emergence. There is some evidence that one may be misled in timing protective applications by data gathered from such traps. It is felt by the writer that emergence cages established under the most natural conditions are the surest indicators of the character of apple maggot emergence.

Since the flies have been found to feed for a considerable time before ovipositing, it is not advisable to begin protective measures at the sight of the first fly but to wait until the numbers of flies appearing in the large cages increases daily, indicating that the peak of emergence is near. Accordingly, various materials were used in spray and dust form to poison the flies during the preoviposition period. In some instances four applications were made and in others, only one. The table lists the details and results of these experiments. Control data was gathered on several different varieties but it was desired to make a comparative list of but one variety here. The efficiency of the materials in control was determined by a close inspection of all apples from each tree by means of a hand lens. Drops were quartered and otherwise dissected to learn the extent of their infestation. Dirty fruit was washed or wiped so that observation could be made more exact. Table 1 shows the results of the treatments.

Though not previously planned, the same Jonathan blocks were used during the three years of experimental work. It is interesting to note that the infestation by maggot in these blocks in 1925, was severe. Hence, extra precautionary measures were taken in 1926 and the results were very satisfactory. In 1927 emergence in this area was light, probably due to the excellent control the previous season and, dry weather. Applications were delayed in waiting for evidence of the approaching peak. Both spray and dust gave promising results. However, an untreated McIntosh orchard near-by was badly infested and the apples were gathered early because of the severe dropping. In 1928 the Jonathan blocks were given no experimental attention, treatments were delayed and as a result both Jonathans and Wealthies in this orchard were rendered unmerchantable by the pest. Also, an untreated McIntosh orchard under observation was found to be badly infested. In 1929 the Jonathans were again taken over for experimental work. Emergence appeared light so that the lead arsenate in the second spray was reduced from two and a half to two pounds per hundred gallons of spray. The trees were not drenched because of possible spray residue and as a result the control was not so complete as anticipated, but the crop as a whole was good. Wealthies in the same orchard and usually heavily infested came thru with very little maggot. Check trees left among treated trees undoubtedly received some protection from drifting spray.

The McIntosh orchard so badly attacked by maggot in 1927 was taken over for experimental work in 1928. Two sprays, the first applied just before the peak of emergence and a second about ten days later showed very promising results of control with lead arsenate as above used. An interesting phase of this work, was that of gathering the drops from each tree at three successive dates. On examination it was found that the apples of the second collection, seven days after the first gathering were more heavily infested than those of the first. The apples gathered last were mainly those knocked down by pickers. In all but one case they outnumbered the apples of the combined two previous collections but had very little maggot. Likewise Wealthies harvested in three successive lots showed a slight gain in maggot at each collection. This indicates that much damage can be done by the pest during the latter part of the growing season if a protective cover is not maintained.

Small screened observation cages set up thru-out the orchards provided opportunity for securing some data on the habits of the flies and their susceptibility to poisons. Most of the cages enclosed fruited spurs which had been treated with sprays and dusts, while others served as

checks. Three cages were maintained for each type of spray or dust. Into one cage of each lot sugar solution was sprayed daily, into another, clear water was introduced while the third was left unchanged. Usually five flies of known age were placed in each cage. As a rule flies in check cages without extra food or water lived but little longer than flies on poisoned foliage. In most instances flies on wetted, poisoned foliage died more quickly than where the foliage was not wetted. Flies on poisoned foliage, fed with sugar daily, lived as long as twenty-seven days and to a great extent paralleled the checks also sugar fed. Not too drastic conclusions can be drawn from the trials with these small cages since the sugar solutions dried on the wire screening and provided poison free areas for feeding.

In conclusion, it appears that the timing of poison applications for apple maggot is best determined by the use of large emergence cages under conditions as nearly natural as possible. One application of spray containing two and a half pounds of lead arsenate to one hundred gallons of the spray, as the flies are beginning to increase in numbers in the cages, and a second spray of the same lead arsenate content about ten days or so after the first, according to intervening weather conditions, will give a large measure of protection from apple maggot. Under dry conditions dust may be used in place of the second spray, or in dry seasons dust may be used altogether. It is well to carefully observe early varieties and protect them first. It has been demonstrated in this work that success in one season is not a guarantee of future freedom from maggot. Where the insect is known to occur in dangerous proportions two spray applications should be made even in the face of a seemingly light emergence. The maintenance of a poison cover whether spray or dust, during the preoviposition period of the flies seems to be a very promising safeguard against apple maggot.

RESULTS OF EXPERIMENTS ON THE CONTROL OF APPLE MAGGOT IN JONATHANS FOR THE YEARS 1926, 1927 AND 1929

Material	Dates of application	Picked apples		Drops		Tree totals		
1926		Total No.	Per-cent mag-got	Total No.	Per-cent mag-got	Total No.	Per-cent mag-got	Per-cent drop
Spray: Lead arsenate (1) 2½–100, Kayso, water	7/8							
Dust: 80–10–10 (2)	7/17; 7/24	902	1.1	320	2.5	1222	1.4	26.2
" 50–40–10 (3)	8/4							
(1 tree)								
Dust: 80–10–10 (2)	7/7; 7/17							
" 50–40–10 (3)	7/25; 8/4	843.3	2.3	171.7	6.5	1015	2.7	22.3
(Average of 3 trees)								

1927								
Spray: Lime-sulfur 1–40 kayso, lead arsenate 2½–100. (Average of 3 trees)	8/2	1408.7	3.8	208.3	13.1	1617	5.2	14.5
Dust: 90–10 (4) (Average of 3 trees)	8/6	1326.3	2.4	217.7	13.3	1544	3.97	14.4
Check: (Average of 3 trees)		894.3	12.	213.6	32.3	1108	16.6	20.1
1929								
Spray: Dry-mix, (5) arsenate of lead 2½–100 (A) (7)	7/13							
Dry-mix, (A) lead arsenate 2–100. (Av. 2 trees)	7/24	1289.5	7.1	111	7.1	1400.5	7.1	7.9
Spray: Dry-mix, (A) lead arsenate 2½–100 (1 tree)	7/13	1499	10.3	84	15.5	1583	10.5	5.3
Spray: Sulfur, tobacco, Kayso,(A) lead arsenate (6) 2½–100	7/13	1544	7.1	87.5	4.95	1582.5	7	5.6
Sulfur, tobacco, kayso, lead arsenate 2–100 (Average of 2 trees)	7/24							
Spray: Sulfur, tobacco, (A) lead arsenate 2½–100, kayso. (1 tree)	7/13	1914	9.9	126	19	2040	10.7	6.2
Spray: Dry-mix, (B) lead arsenate 2½–100	7/14							
Dry-mix, (B) lead arsenate 2–100 (Av. 3 trees)	7/25	936	7.4	107.7	7.2	1043.7	7.1	8.6
Spray: Dry-mix, lead arsenate (B) 2½–100	7/14	2460	14.6	156	9.6	2616	14.2	5.96
Spray: Lime-sulfur, (A) lead arsenate 2½–100	7/16							
Lime-sulfur, kayso, (A) lead arsenate 2–100 (Average of 2 trees)	7/25	2999	11.9	250	13.	3249	12.	7.7
Spray: Lime-sulfur, 1–40 kayso, (A) lead arsenate 2½–100 (Average of 2 trees)	7/16	2187.5	11.7	188	15.2	2375.5	11.9	7.25
Check (among sprayed trees)		2167	12.7	135	7.4	2362	12.4	5.9
Check (more isolated, in orchard sprayed late)		495	30.3					

NOTE: 1. 2½ lbs. lead arsenate to 100 gallons of spray.
2. 80 lbs. sulfur, 10 lbs. lime and 10 lbs. lead arsenate.
3. 50 lbs. sulfur, 40 lbs. lime (hydrated) and 10 lbs. lead arsenate.
4. 90 lbs. sulfur and 10 lbs. lead arsenate.
5. 16 lbs. sulfur, 8 lbs hydrated lime and 4 oz kayso in 100 gallons spray.
6. 16 lbs. sulfur, 8 lbs. tobacco dust and 4 oz kayso in 100 gallons spray.
7. (A) (B) two different commercial brands of lead arsenate.

Scientific Notes

Note on Plebeius acmon Doubleday and Hewitson. On April 4, 1930, Dr. H. Schmidt, Veterinarian, Texas Agricultural Experiment Station, found the pods of *Astragalus trifloris* Gray to be heavily infested with lepidopterous larvae, apparently of one species. The locality was about thirty-five miles south of Marfa, Texas. A number of the infested plants were brought back to College Station and turned over to the Division of Entomology. An attempt was made to rear the larvae to maturity on the plants but it was impossible to keep the plants from drying up. Since *Astragalus trifloris* does not occur in the vicinity of College Station, a number of larvae were transferred to the pods of English peas. The larvae did not take readily to this food supply but four of them finally pupated. From these pupae four butterflies emerged. These were identified by Dr. W. Schaus of the Bureau of Entomology, U. S. D. A. as *Plebeius acmon* Doubleday and Hewitson.

Astragalus trifloris, known by the common name of Garbancillo, is thought by the ranchmen of the vicinity of Marfa to be poisonous to livestock. About eighty per cent of the pods of the plants examined were infested.

ROBERT K. FLETCHER, *Division of Entomology, Texas Agricultural Experiment Station*

A New Method of Distributing *Empoasca fabae* (Harris). Early in 1930, Mr. Lacy McColloch of the Bureau of Plant Industry, U. S. Department of Agriculture, called attention to insects on green beans which had been shipped from Florida, and which were being used for study of certain diseases of beans in cold storage at Arlington Farm by Dr. J. I. Lauritzen. The insect proved to be the potato leafhopper, *Empoasca fabae* (Harris). Apparently there is no previously published record that this species deposits eggs in the pods of green beans under field conditions. These insects were received in green beans of the Bountiful variety as early as January 27 from Fort Lauderdale, Florida, and later they were abundant in the beans received from Delray Beach, Florida, as many as seven individuals hatching from a single bean pod. Investigation also revealed the presence of small leafhopper nymphs on green beans which had been received from Florida and were being offered for sale in Center Market, Washington, D. C.

Records on hatching were noted in two instances, as follows: Beans received March 14, which had been kept in individual lots at temperatures of 21°, 25°, 27°, and 29° C., respectively, showed little difference in the time and amount of hatching when kept at room temperatures in the laboratory following their removal from storage on March 21; a second series of four lots of material, kept at 4.5°, 7°, 12°, and 15° C., respectively, for a week preceding March 28, was kept under observation at room temperatures following this period. It was found that hatching continued until April 17 in the case of the lot which had been kept at 15° C. Less hatching apparently occurred in the lots which had been kept in storage at the lower temperatures.

Upon inquiry, I was advised by Mr. W. H. White of the Division of Truck-Crop Insects, Bureau of Entomology, that a similar instance, whereby *Empoasca* was shipped to Washington in beans from Florida, was called to his attention in 1927 by Dr. L. L. Harter of the Office of Vegetable and Ornamental Diseases, Bureau of Plant Industry.

F. W. POOS, *Bureau of Entomology, U. S. Department of Agriculture*

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

AUGUST, 1930

The editors will thankfully receive news matter and other items likely to be of interest to our readers. Papers will be published as far as possible in the order of reception, except that papers of reasonable length may be accepted in the discretion of the editor for early publication at $2.50 per page for all matter in excess of six printed pages, a part page counting as a full page, this limit not including acceptable illustrations. Photo-engravings may be obtained by authors at cost.

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ANNUAL SCIENTIFIC MEETINGS: 1930-31, Cleveland; 1931-32, probably New Orleans; 1932-33, Chicago; 1933-34, undecided; 1934-35, probably Rochester.

Few can keep in touch with the exceedingly diverse literature of entomology. One of the more recent additions is entitled: Mediterranean Fruit Fly, Hearing Conducted at Orlando, Florida, by the Special Subcommittee of the House Committee on Appropriations. There are only 1483 printed pages. It is verbose. It reflects the opinions and beliefs of diverse individuals and the reader, whether in favor of eradication or opposed to it in one or more phases, can find within the volume endorsement of his views. One can not but commend the desire of the committee to get at the facts in the face of diverse and sometimes contradictory statements. It is evident that an astonishing reduction in the infestation was effected. There is, as was to be expected, diversity of opinion as to the wisdom or necessity of certain regulations and their enforcement. One may find strong condemnation of certain types of publicity. It is an illuminating publication in its presentation of the psychology of one phase of quarantine and as such may prove a real contribution to economic literature. The last ten years has witnessed a remarkable development in quarantine work and it is only by a careful study of all phases that a satisfactory policy can be determined. This volume on the Mediterranean Fruit Fly is available through the Government Printing Office and in the writer's judgment is worthy of careful study by all interested in quarantine problems.

Reviews

A Manual for the Study of Insects, Revised Edition by JOHN HENRY COMSTOCK, ANNA BOTSFORD COMSTOCK and GLENN W. HERRICK, Nineteenth Edition, pages i–xiii, 1–401, 635 test figures, 3 plates. Comstock Publishing Company, Ithaca, N. Y., 1930.

It was the reviewers good fortune to see a little of the work involved in the preparation of the first edition of this classic of American entomology and it has been a source of gratification to note subsequent editions. This series of "Manuals" have meant much to the entomological students of America and have had a determining influence upon the development of the science throughout the world, since they represent years of productive labor by a master and his associates in the general field of entomology, as well as occasional departures into a few specialized fields. The Comstock Manuals have abundantly justified themselves and carry their own credentials. All familiar with them will rejoice greatly in this latest edition, with an additional co-author, somewhat condensed, conserving most carefully the general lines of the earlier editions and brought down to date.

E. P. F.

Current Notes

Mr. R. E. Balch, Entomological Branch, is at present on Cape Breton Island conducting investigations on the black-headed budworm, *Peronea variana*.

Dr. J. M. Aldrich, of the U. S. National Museum staff, has gone to the western United States for two months and will spend some time there collecting Diptera in high altitudes.

Mr. James B. Gahan, who received his B. S. degree in June, from the University of Maryland, has been appointed to a position with the Bureau of Entomology. He will work at the Sligo, Maryland, Laboratory.

O. E. Gahm, Bureau of Entomology, Arlington, Va., and H. D. Young, of the Bureau of Chemistry and Soils, visited Barberton, Ohio, May 19 and 20, to conduct some experimental tests on fumigation in the mushroom plant of Yoder Brothers.

O. E. Gahm, Bureau of Entomology, Arlington, Va., left Washington, May 31, for points in the West and the Pacific Coast, to study the occurrence of mushroom pests in commercial mushroom houses. He returned to Washington, July 8th.

Field assistants, Bureau of Entomology, who have recently been appointed are W. C. Pierce, for service at Baton Rouge, La., E. B. Wiggins, at Estancia, N. M., L. L. Odom, at Bay St. Louis, Miss., A. L. Strand, at Walla Walla, Wash., and W. J. Gertsch, at Richfield, Utah.

In May four students, H. A. Bess, of the University of Florida, G. G. Cannon, of the University of Kansas, and D. W. Farquhar and C. W. Lacaillade, Jr., of Harvard University, were given temporary appointments as field assistants at the Gipsy-Moth Laboratory, Melrose Highlands, Mass.

Mr. Ralph Hopping, Entomological Branch, left Vernon, B. C., on April 6, for California, where he is spending two months sick leave. During his absence Mr. W. G. Mathers, who has returned from taking graduate studies at Syracuse University, will take charge of the Vernon forest insect laboratory.

Dr. A. G. Böving, the Bureau of Entomology specialist on coleopterous larvae, recently received from J. C. M. Gardner, of the Forest Research Institute and College, Dehra Dun, India, a series of beetle larvae, including cotypes of species described by him in an extensive paper on the immature stages of Indian Coleoptera.

W. E. Haley, Bureau of Entomology, of the field laboratory at New Orleans, La., spent about three weeks in May visiting the sugar-cane sections of Florida, to investigate the situation as to the sugar-cane moth borer, and to make a special study of the parasites of this insect.

Mr. K. E. Schedl, Entomological Branch, left Ottawa on May 3 for Biscotasing, Ont., where he is establishing a camp to study the biology of the jackpine sawfly, which is affecting jackpine over a large area. Mr. M. B. Dunn will shortly leave Ottawa for Kippewa, in western Quebec, to carry on similar studies.

General parasite breeding work is being continued at the Belleville, Ont., laboratory, Entomological Branch. On April 2, 18,000 wheat stem sawfly larvae infested with the parasite, *Collyria calcitrator*, were received from the Imperial Bureau of Entomology Parasite Laboratory at Farnham Royal, England. It is intended to liberate these parasites in areas infested with *Cephus cinctus*.

David Isler, Bureau of Entomology, who has been in charge of investigations on cultural control of the pink bollworm, has been transferred to Tallulah and placed in general charge of the mechanical investigations of the Division of Cotton Insects. This work is conducted in cooperation with the Division of Agricultural Engineering of the Bureau of Public Roads.

On May 31 R. A. St. George, Bureau of Entomology, left Falls Church for Asheville, N. C., to assume charge of the work at the field laboratory there for the coming summer. He will be assisted by R. W. Caird, of the University of Chicago, who is making a physiological study of trees attacked by the barkbeetle, and Messrs. Pawek and Huckenpahler, from the University of Minnesota.

Mr. Norwood A. Eaton, a graduate of the University of Maryland, B. S. 1927, M. S. 1928, has been appointed to a position with the state of Virginia. Mr. Eaton will have charge of the entomological laboratory which has been recently established at Charlottesville, Va. Mr. Eaton was with the Plant Quarantine and Control Administration after leaving college, first at the port of New York, and later Philadelphia.

The Division of Forest Insects, Bureau of Entomology, in cooperation with the Extension Service, has recently prepared a film strip on the control of subterranean termites attacking the woodwork of buildings. We believe that this strip will prove very useful to State entomologists and other entomologists who are called upon to remedy conditions where termites have attacked buildings. The strip will be ready in the near future.

W. A. Thomas, Bureau of Entomology, Chadbourn, N. C., visited Washington May 14, to make a survey of the strawberry plantings at Bell, Md., in company with G. M. Darrow, of the Bureau of Plant Industry. They went there to determine the varying susceptibility of the different varieties of strawberries to attack by insects. Mr. Thomas also made a survey for infestations by the strawberry weevil on the Eastern Shore of Maryland and in Delaware.

Professor and Mrs. Geo. A. Dean sailed from Montreal, Canada, July 12, on the S. S. "Duchess of York" for a business and pleasure trip to Europe. Professor Dean's official work in connection with insects infesting export flour will take him into England, Scotland, Ireland, Norway, Sweden, Denmark, Germany, Belgium, and Holland. Professor and Mrs. Dean hope they will also have time to visit France, Switzerland and Italy.

On April 11, Mr. A. B. Baird, Entomological Branch, returned from a brief visit to the corn borer laboratory at Arlington, Mass., with a large supply of cocoons of the corn borer parasites, *Microgaster tibialis* and *Eulimneria crassifemur*, emerging adults from which will be liberated later in the season. On April 28, a small shipment of *Chelonus inanitis*, a species which parasitizes the eggs of the European corn borer, was received from the Arlington Laboratory.

C. F. Moznette, Bureau of Entomology, in charge of pecan-insect investigations, with headquarters at Albany, Ga., and T. L. Bissell, of the pecan-insect laboratory at Experiment, Ga., attended the twenty-fourth annual convention of the Georgia-Florida Pecan Growers Association, April 18 and 19. Mr. Moznetto presented a paper entitled "Relative efficiency of lead arsenate and calcium arsenate in controlling the pecan leaf case-bearer," and Mr. Bissell gave one entitled "Some facts about the pecan weevil."

Mr. Castillo Graham, who received his Bachelor of Science degree from the Mississippi Agricultural and Mechanical College in 1928, received his Master's degree in June from the University of Maryland. Mr. Graham has been connected with the Extension Service, University of Maryland, having charge of the spray service, and certain fruit insect investigations for the western portion of Maryland. Mr. Graham is located at Hancock, Maryland, during the summer months. He will continue work this fall toward his Doctor's degree.

R. A. St. George, Bureau of Entomology, spent the week of April 28 at Madison, Wis., attending the Forest-Service conference there, and took part in the proposed economic survey of forest resources. Doctors E. Bateman, Senior Chemist, and Caroline T. Rumbold, Assistant Pathologist, Forest Products Laboratory, were consulted regarding certain phases of the work in tree injections that is being conducted by the field laboratory at Ashville, N. C., with the object of finding a more economical method of control for trees attacked by the barkbeetle.

In May, Mr. B. R. Coad, Bureau of Entomology, visited the field laboratory at El Paso, Tex., for the study of the pink bollworm, the one at Tucson, Ariz., for investigating the thurberia weevil, and the one at Calexico, Calif., where investigations of the cotton leaf perforator are being conducted. He also inspected the activities of the Plant Quarantine and Control Administration in eradicating the pink bollworm in the Salt River Valley of Arizona. The various projects for the coming season were reviewed and future activities were outlined.

Dr. Clarence E. Mickel, Assistant Professor of Entomology and curator of the insect collection in the University of Minnesota, has been awarded a Guggenheim Fellowship for a year's study in Europe, to work on the neotropical and Philippine Mutillidae. Dr. Mickel will study principally in England, France and Germany where most of the type material for these faunas is to be found. The work will be a continuation of that carried on at the U. S. National Museum for the Bureau of Entomology during the summers of 1928 and 1929.

Leaving Washington May 8, W. H. White, Bureau of Entomology, visited the lower section of South Carolina, to look over locations there suitable for the establishment of a field laboratory devoted to work on the sandy-land wireworm. He visited the field laboratory at Chadbourn, N. C., and conferred with W. A. Thomas and C. F. Stahl on the problems of the strawberry weevil and the root aphid. He also stopped at Charleston, S. C., to discuss with W. J. Reid Jr., the problem of the seed-corn maggot, and returned to Washington May 12.

Dr. Filippo Silvestri, who has been visiting Professor at the University of Minnesota, giving a course of lectures on economic entomology during the spring quarter, has presented the library of the Department of Entomology at that institution with a complete set of his publications. It is therefore possible at the present time for students in America to secure very easily any paper of Dr. Silvestri's through the University Library Exchange offices. After leaving the University of Minnesota, Dr. Silvestri was guest for a week at the State College of Iowa at Ames and has since been collecting and visiting laboratories and institutions in the western states.

Mr. Harry Wells, of Chevy Chase, Maryland, and a graduate of the College of Engineering, University of Maryland, returned in March from a year's expedition in Central Borneo, where he was in charge of radio investigations for the All-American Mohawk Malaysian expedition. While in Borneo and later in Java, Mr. Wells sent the Department of Entomology two lots of exotic Lepidoptera. It is hoped that some of this material may prove interesting, as Wells and his companions penetrated deep into the jungles of Borneo, and no doubt made some of his collections in situations where entomologists have never been.

Mr. William T. Henerey, who received his Master of Science degree from the University of Maryland in June, was recently appointed Assistant Extension Entomologist for the Pennsylvania State College. Mr. Henerey will have charge of the western counties in the state. He succeeds Mr. Pepper, who has recently resigned. He is a graduate of Clemson College in the class of 1926. After leaving school Mr. Henerey spent a year with the International Health Board, working under, Dr. Mark F. Boyd at the Edenton, North Carolina, Laboratory, and the following year returned to the South Carolina Experiment Station to work with Dr. C. O. Eddy.

Doctor F. C. Craighead, Bureau of Entomology, spent May 14, 15 and 16 with Messrs. E. E. Carter, M. W. Thompson and A. L. Nelson, of the Forest Service, and L. G. Baumhofer, formerly with the Bureau of Entomology, on the Nebraska National Forest, in a field examination of the plantations at Halsey. The improved appearance of the yellow pine trees resulting from the decrease in infestation of the tip moth brought about by the introduction of the parasite Campoplex was most gratifying. It is hoped that the parasite will bring about sufficient control to permit of the growth of this important species of yellow pine in the vicinity of Halsey. Plans for carrying out control work against infestation by the pitch moth in jack pine were considered and will probably be put into effect next fall.

Professor William B. Herms, Professor of Parasitology at the University of California, gave an illustrated lecture at the Franz Theodore Stone Laboratory of the Ohio State University, at Gibraltar Island, Put-in-Bay, Ohio, on the evening of July 25th. His lecture dealt mainly with the fauna and flora of certain typical coral atolls of the Mid Pacific Ocean. Professor Herms is a visiting

professor at the Ohio State University during the summer quarter, where he is giving a graduate course in Medical Entomology and is directing the work of certain graduate students in this field. He will return to his post in Berkeley, California early in September.

The 421st regular meeting of the Washington Entomological Society was held at the University of Maryland, College Park, on the evening of June 5th when the members of the Department of Entomology of the University were hosts to the Society. Prior to the meeting in the University Auditorium, more than a hundred members of the Society and their families spread box lunches on the campus and enjoyed a picnic supper. The Department of Entomology supplemented the box lunches with ice cream and milk drinks from the University Dairy. The party then proceeded to the University Auditorium where Dr. H. J. Patterson, Dean of the College of Agriculture and Director of the Experiment Station, welcomed the Society to the Maryland campus. Following a presentation of a chronological list of entomologists who had worked at Maryland by Dr. Ernest N. Cory, Head of the Entomology Department, Dr. L. O. Howard gave a most interesting discussion of some of the early entomologists at Maryland, with particular reference to C. V. Riley and Townend Glover. Dr. W. Dwight Pierce gave a review of some of the work he has been doing in the Phillipine Islands on the effect of temperature and moisture on insect life. Before adjournment the Society gave a rising vote of thanks to Dr. Cory and his assistants for a most enjoyable evening.

Horticultural Inspection Notes

The Oregon State Agricultural College in June issued Circular of Information No. 30, entitled "Recommendations for Eradication of Nematodes from Narcissus."

Mr. L. R. Warner, in charge of port inspection work for the State Plant Board of Florida at Key West, is reported to be ill at his former home in Pennsylvania.

Under Amendment No. 1 to Arizona Quarantine No. 1, on account of the alfalfa weevil, the importation of Idaho apples in baskets as well as boxes has been authorized.

Colonel Aird, a lily grower, has recently been made a member of the State Board of Horticulture of Oregon, and to him the Board has delegated general responsibility for narcissus inspection in that State.

Mr. R. N. Dopson, Jr., is at present employed in making inspections of the premises and environs of peach-growing nurseries in Georgia and Alabama, under the provisions of the Federal phony peach disease quarantine.

Mr. E. J. McNerney, who has been assisting in the enforcement of the car cleaning requirements of the Mediterranean fruit fly quarantine at New York and various other points during the past year, has been transferred to Boston, where he will be engaged in similar work.

A special meeting of the Southern Plant Board was held at Gatlinburg, Tennessee in the new Smoky Mountain National Park, on July 16. In addition to delegates from the southern States, there was present Mr. Lee A. Strong, Chief of the Federal Plant Quarantine and Control Administration.

Mr. J. M. Corliss of the Chicago office of the Plant Quarantine and Control Administration spent several days in Michigan during June, visiting the premises of

narcissus growers and conferring with the State inspectors who were engaged in the field inspection of narcissus at that time.

The Connecticut Agricultural Experiment Station in May published Circular 70, entitled "Nursery Sanitation Zones," by J. E. Riley, Jr. The circular includes maps of the various blister rust control areas established in Connecticut around the principal pine-producing nurseries of that State.

Mr. Hunter H. Kimball, who has been Chief Inspector of the Mississippi State Plant Board for several years, resigned in May to accept an appointment with the U. S. Department of Agriculture in charge of field scouting and eradication activities connected with the Mediterranean fruit fly campaign in Florida.

The production and harvesting period of Florida grapes and host vegetables has been extended by the United States Department of Agriculture to July 16 for cantaloupes and host vegetables, and August 1 for grapes. The new order became effective June 21, and was published as circular PQCA-282.

Mr. G. C. Chauncey, who has been stationed at the railroad diversion point at Waycross, Ga., to aid in the enforcement of the Mediterranean fruit fly quarantine regulations, and Mr. L. L. O'Steen, who has been similarly engaged in Savannah, Ga., have been transferred for the summer to the fruit fly work in Florida, with headquarters at Orlando.

Mr. G. W. R. Davidson of the Plant Quarantine and Control Administration and Dr. L. M. Hutchins of the Bureau of Plant Industry, made an extended field trip through Alabama, Mississippi, Louisiana, Arkansas and Tennessee during May and June to search for possible phony peach disease infections. A few trees showing the symptoms of this disease were found at a number of locations on the trip.

Mr. R. A. Sheals and Mr. C. B. Beamer of the Plant Quarantine and Control Administration spent several weeks during June and July in the New England States and New York making special inspections of the environs of nurseries who have applied for special permits to ship white pines to lightly infected States under the provisions of Regulation 2 (d) of the Federal white pine blister rust quarantine.

On March 31, the Arkansas State Plant Board revised the restrictions governing the introduction of sweet potatoes and sweet potato plants to authorize their entry into that State under Arkansas permit, from the entire State of Oklahoma and from weevil-free areas Nos. 2 and 3 of Texas. Heretofore entry of these products from the entire State of Texas and from two counties in Oklahoma was prohibited.

The regulations supplemental to Federal quarantine No. 13, restricting the transportation of fruits and vegetables for Hawaii to the continental United States on account of the Mediterranean Fruit Fly and the melon fly, have been revised effective June 1 to add lily and ginger roots to the products which may be shipped to the mainland subject to inspection and certification in Hawaii. Other minor changes are made in the requirements.

Mr. C. R. Stillinger, in charge of the transit inspection work of the United States Department of Agriculture in the Pacific Northwest, with headquarters in Spokane, Washington, spent much of May and June assisting the Oregon State inspectors in making field examinations of narcissus plantings. The bulb eelworm has been found much more extensively scattered in Washington and Oregon than had previously been believed.

On April 8, the Plant Quarantine and Control Administration issued regulations governing the compensation of farmers on account of losses which may be sustained because of the enforced nonproduction of cotton in noncotton zones established for the purpose of eradicating the pink boll-worm. These regulations are primarily applicable at the present time to the pink bollworm outbreak in the Salt River Valley of Arizona.

On June 19 the Maryland Agricultural College and the State Board of Agriculture issued a revision of the State quarantine regulating the intrastate movement of nursery stock, farm products and soil to prevent the spread of the Japanese beetle. In addition to including all the requirements of the Federal quarantine on this subject, the State regulations provide special additional restrictions on the intrastate movement of these products into certain sections of Baltimore and Harford counties.

The Federal white pine blister rust quarantine regulations were revised on June 5. The primary purpose of the revision was to extend the area designated as infected with the blister rust to include the State of Montana and those parts of Oregon not heretofore so designated. Other changes of general interest related to the movement of Christmas trees, the removal of certain special sanitation requirements so far as they applied to the shipment of five-leafed pines from New York to the New England States and vice versa, and the placing of additional restrictions on the movement of five-leafed pines from Oregon and Idaho.

Mr. Paul H. Millar, Chief Inspector of the Arkansas State Plant Board, reports that during the fiscal year ended June 30, 1930, inspectors of the Board made terminal and transit inspections of 4,072 plants in 53 shipments of nursery stock and condemned 40 such plants. The pests and diseases involved were largely woolly aphis, crown gall and blotch canker. This was in addition to the inspection of 1,486 crates of onions from Texas, of which 114 were condemned on account of pink root disease, and 598 crates of strawberry plants from Arkansas, Iowa, Indiana, Kansas, and Maryland, of which nine crates were condemned as containing old plants and thirty-three crates on account of nematode infestation.

Cotton produced in the counties of Chaves, Eddy and Otero in New Mexico; the counties of Andrews, Glasscock and Martin, and the regulated parts of Borden, Dawson and Howard in Texas, was released by the Plant Quarantine and Control Administration from the fumigation requirement, effective June 1. In making the announcement the Administration stated that these were counties within which and within five miles of which no pink billworm infestation had been found during the past two crop seasons, also that no infested seed cotton is known to have been ginned in that area during this period, and that all cotton seed produced therein is being satisfactorily sterilized in cotton seed heating machines. The release from the fumigation requirement does not apply to picker waste and forms of unmanufactured cotton fiber other than samples for commercial baled lint and linters.

The Atlanta office of the Administration which had acted as headquarters for the Mediterranean fruit fly work outside Florida has been discontinued. The road station activities on the Florida border will hereafter be directed from Orlando by Mr. L. M. Gaddis under the general direction of Prof. W. C. O'Kane, while the quarantine enforcement work at railroad diversion points in the South and the enforcement of the restrictions prohibiting reshipments of Florida products from northern to southern States will be administered by the Domestic Plant Quarantine

Office of the Administration at Washington, through Mr. G. W. R. Davidson, who will be in immediate charge. No general program of surveys for the fruit fly outside of Florida will be undertaken by the Federal department this season. Mr. P. A. Hoidale, who has been in charge of the Atlanta office for the past year, is resuming his former duties in charge of the Mexican fruit worm work at Harlingen, Texas.

Apicultural Notes

Harley W. Roath, L. E. McDonald, Russell Smith, and Wm. C. Northrup have been appointed Field Assistants, Bureau of Entomology, to help with experiments under way at the Intermountain Bee Culture Field Laboratory, Laramie, Wyo.

Dr. W. E. Dunham, of Ohio State University, has been given a temporary appointment to assist in experiments in the pollination of red clover, to be conducted this summer at Holgate, Ohio, by the Bee Culture Laboratory, Bureau of Entomology.

J. E. Eckert, of the Intermountain Bee Culture Field Laboratory, Bureau of Entomology, Laramie, Wyo., has been granted leave of absence to attend the graduate school of Ohio State University during the coming fall term, and has been appointed Fellow in Entomology for 1930-31.

Dr. L. M. Bertholf has been appointed Field Assistant, to continue investigations at the Bee Culture Laboratory, Washington, on the effect of various wave lengths upon the honeybee. At the termination of the temporary appointment Doctor Bertholf will go Munich, Germany, to study with Prof. Karl von Frisch, of the University of Munich, on a National Research Council fellowship.

Dr. Tomi Yoneda, of the Department of Animal Industry, Ministry of Agriculture and Forestry, Tokyo, Japan, visited the Bee Culture Laboratory at Washington, D. C., May 20 to consult with members of the staff on matters relative to the production, marketing and grading of honey. According to Doctor Yoneda, an effort will be made in Japan to interest farmers in keeping colonies of bees.

Dr. L. R. Watson, of Alfred, N. Y., formerly connected with the Division of Bee Culture Investigations, visited the Bee Culture Laboratory, Washington, D. C., in the latter part of May. Besides his investigations on the artificial insemination of queenbees and research on the composition of beeswax, Doctor Watson, with the assistance of Mrs. Watson, has developed a formula by which honey is utilized in the making of an unusually fine grade of assorted chocolate candy.

Notes on Medical Entomology

On May 17 F. C. Bishopp, Bureau of Entomology, visited Dr. Baer, of Johns Hopkins University, at Baltimore, Md., for consultation with regard to the use of blowfly maggots in treatment of cases of osteomyelitis.

Professor J. H. Ashworth of the Department of Zoology, Edinburgh University, recently spent a day visiting the Department of Entomology at Cornell University. He was particularly interested in the work being done in the field of Culicid biology.

Messrs. Arthur Gibson and C. R. Twinn, of the Entomological Branch, visited Montebello, Que., on April 12, to assist officials of the Lucerne-in-Quebec Community Association in planning work with a view of eliminating mosquitoes from the neighbourhood of this recently organized and important summer resort. Mr. Norman Atkinson, formerly an officer of the Branch, attached to the Saskatoon Laboratory, has been appointed by the Association to take charge of this project.

Mr. C. R. Twinn, of the Entomological Branch, visited Camp Borden, May 1–8, at the request of the Department of National Defence, to organize mosquito control work at the Air Force camp for the current season. While at Camp Borden, Mr. Twinn made aerial and ground surveys of the surrounding district and secured larval collections representative of the local mosquito fauna. Before returning to Ottawa a brief visit was made to Orillia where the local mosquito control committee is continuing its activities.

Mr. E. H. Hinman, a graduate student in the Department of Entomology of the New York State College of Agriculture at Cornell University has recently been appointed to a National Research Fellowship in the Biological Sciences. Mr. Hinman is a graduate of Queen's University, Canada, class of 1927. He received his doctor's degree at the June Commencement of Cornell University. While a graduate student, Mr. Hinman specialised in the field of Medical Entomology and has made a distinct contribution to the problem of the nutrition of aquatic organisms, particularly mosquito larvae. In association with Professor Robert Matheson he also contributed to an intensive study of the effects of aquatic plants on mosquito development and the value of plancton and bacteria as food factors in larval development. This latter work was made possible by a grant from the Heckscher Research Foundation of Cornell University. As a National Research Fellow Mr. Hinman will continue his investigations at Tulane University Medical College working in association with Dr. C. C. Bass, Dean of the Medical College, and Dr. E. C. Faust, Professor of Parasitology, in the same institution.